

DECEMBER 25¢

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PAGE
67



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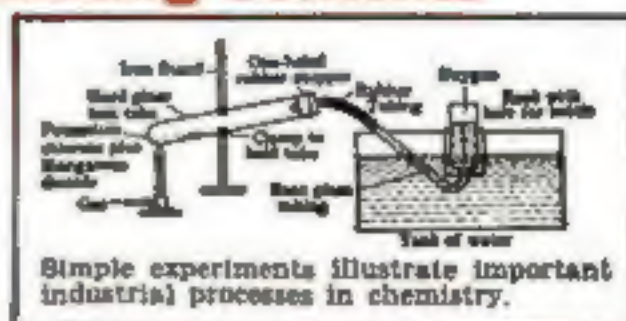
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Mechanics & Handicraft

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THE WINNER of first prize, non-professional class, in the big Popular Science "Plane You'd Like to Own" contest is 17-year-old Pfc. Don LeRoy Fotheringham, USMC. He sketched his ideas in his "foxhole school" in the Pacific, where he went in with the leathernecks at Roi, Namur, and Saipan. His \$1,000 War Bond prize will help him to realize his own postwar plan of going to college.

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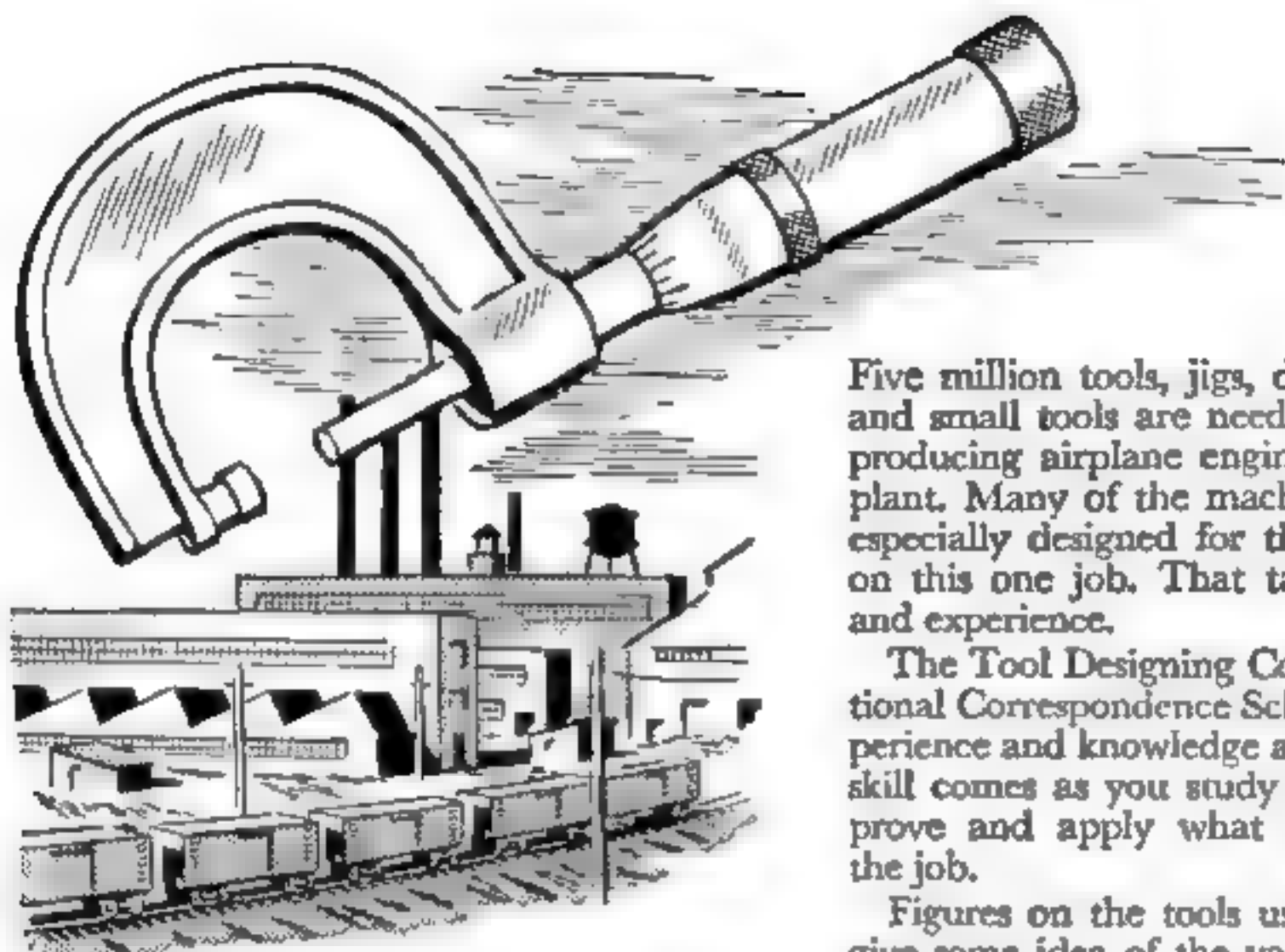
"ANN'S" KISS costs thousands of American lives every year. "Ann" is the jungle fighters' name for the female anopheles mosquito, carrier of the deadly malaria parasite. You ought to know about this dread disease, which is prevalent in many parts of the world, and what is being done to curb it by preventive measures and new synthetic drugs. Here is the story, with illustrations in color.

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AMERICA HAS LED THE WORLD with inventions of basic importance—the grain harvester, cotton gin, sewing machine, airplane, air brake, oil cracking, steamboat, rubber vulcanizing, and others. Read in next month's issue how these fundamentals of present world progress were evolved by their brilliant originators. This is the first of two installments that should make every United States citizen proud of his heritage.

FARMERS HAVE DONE A GREAT JOB for America and her allies during the past three years under increasingly difficult circumstances, which have included the lack of new machinery. Did this get them down? No, they used their ingenuity, mechanical ability, and brawn to build, improvise, and repair what they already had or could collect from junk yards. You'll want to know what they did and how they did it. You may, by reading this article.

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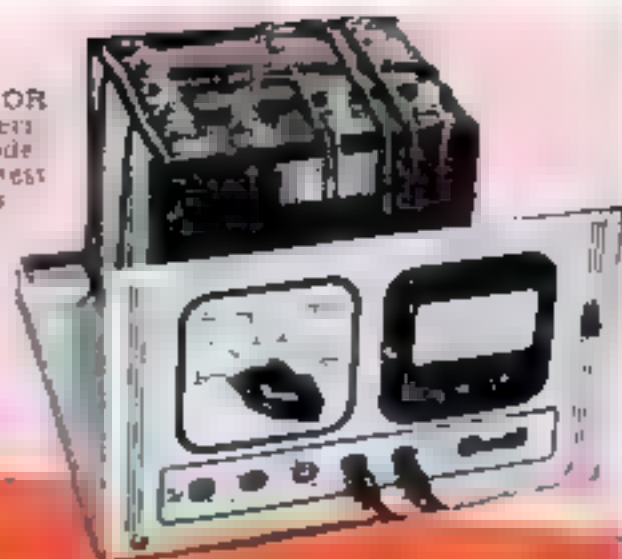
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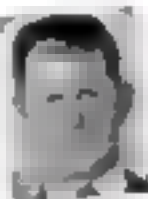
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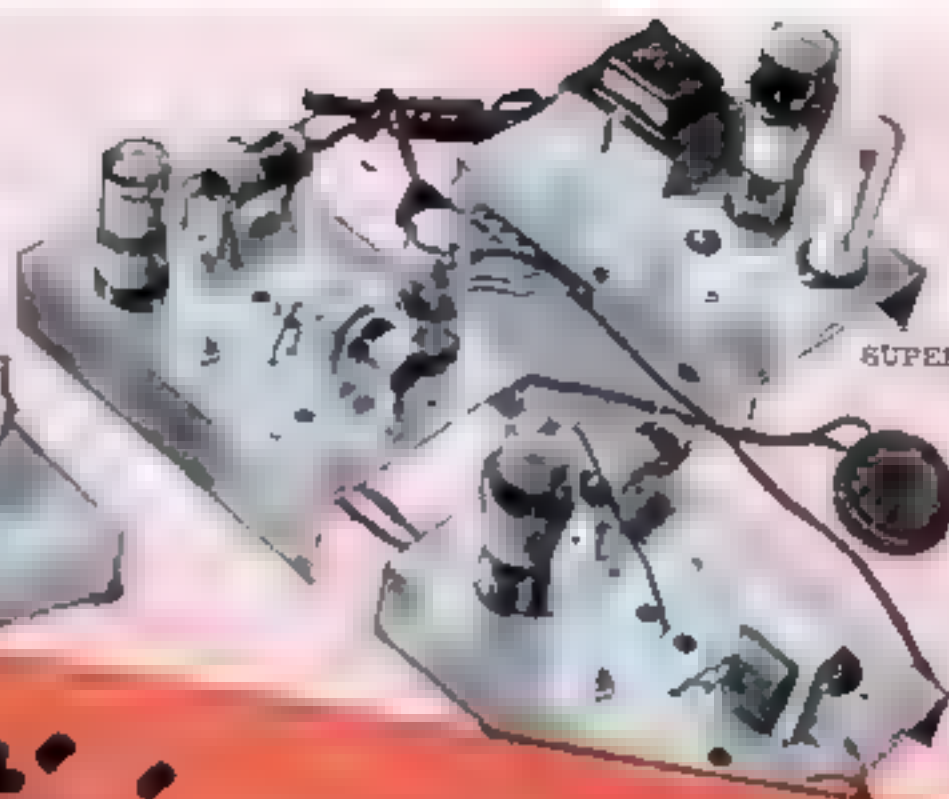
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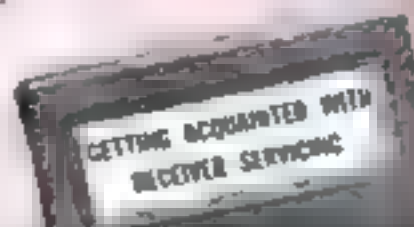
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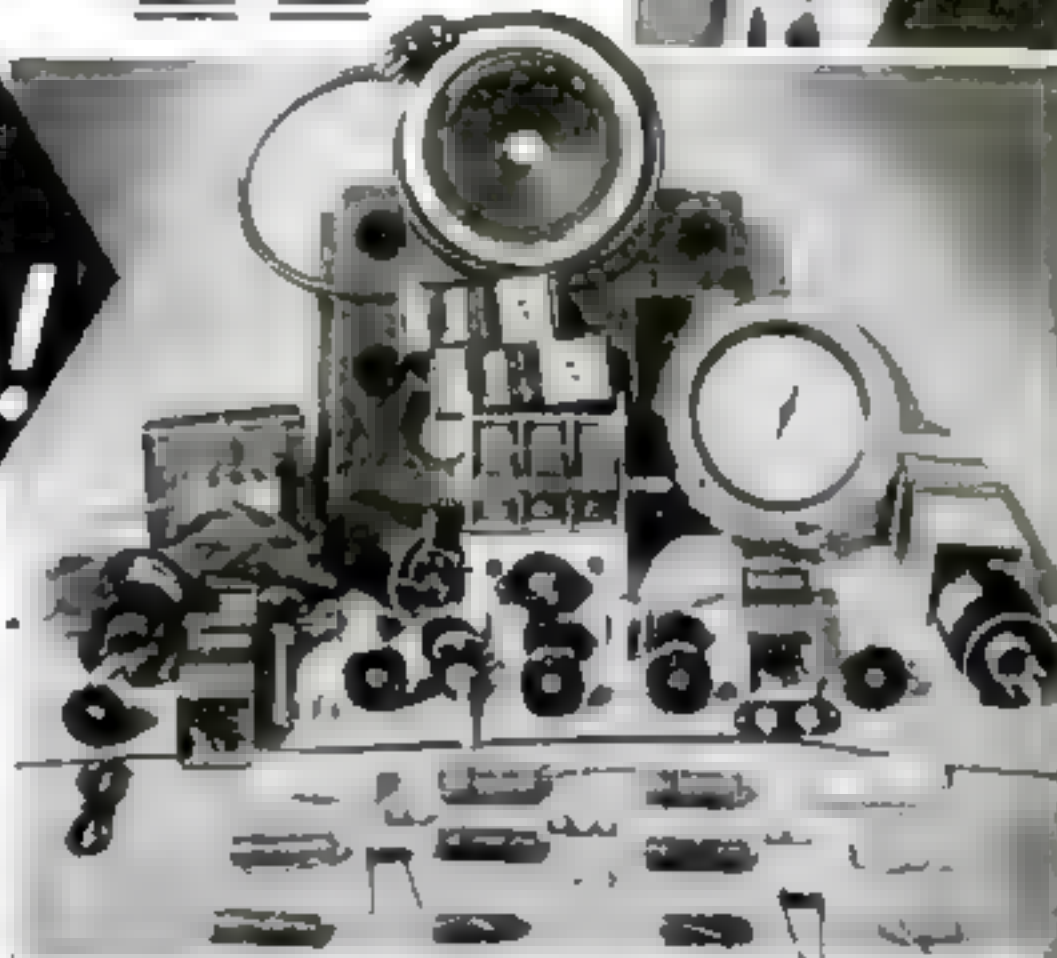
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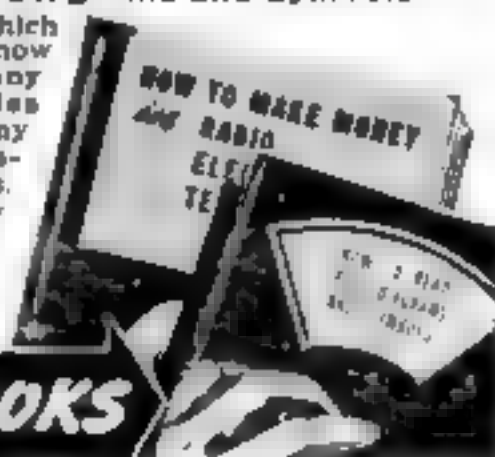
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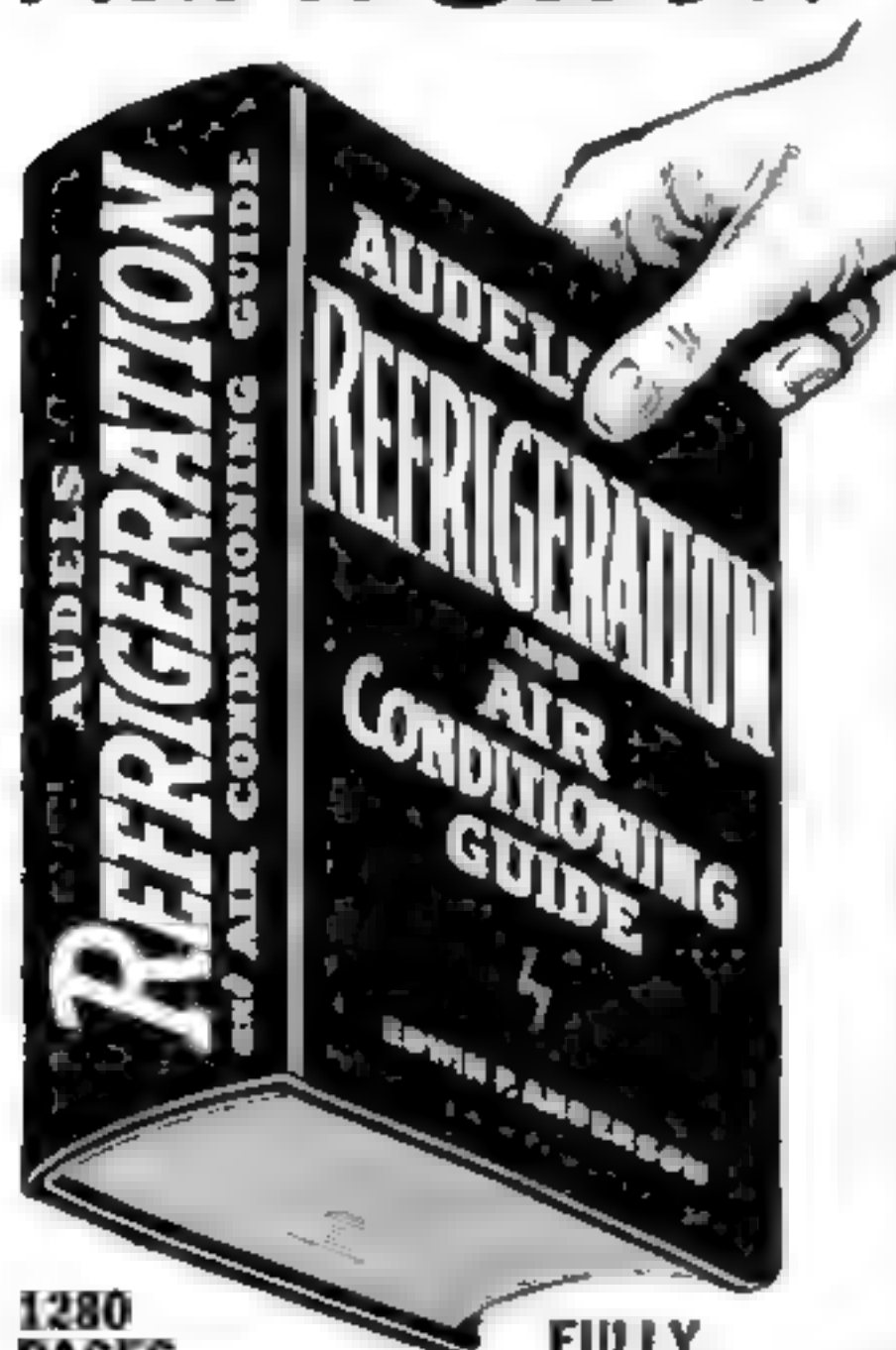
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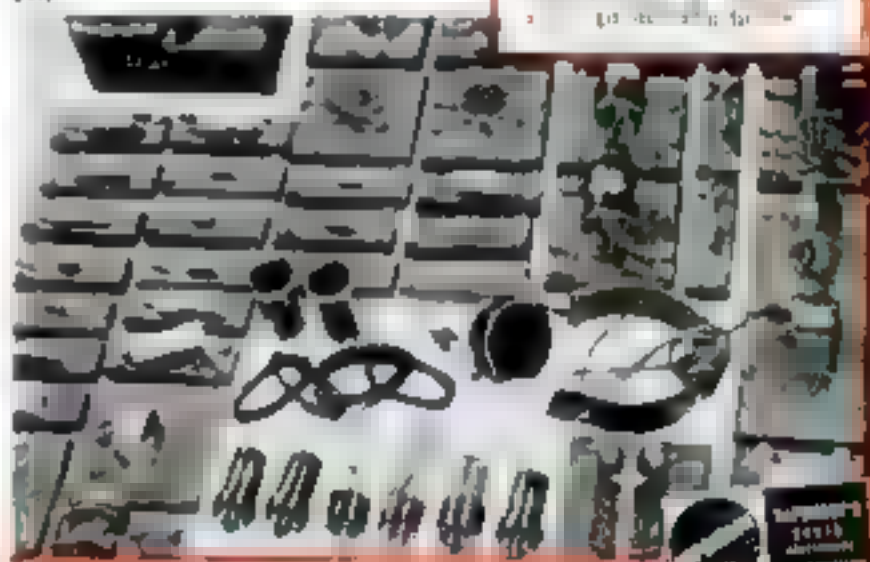
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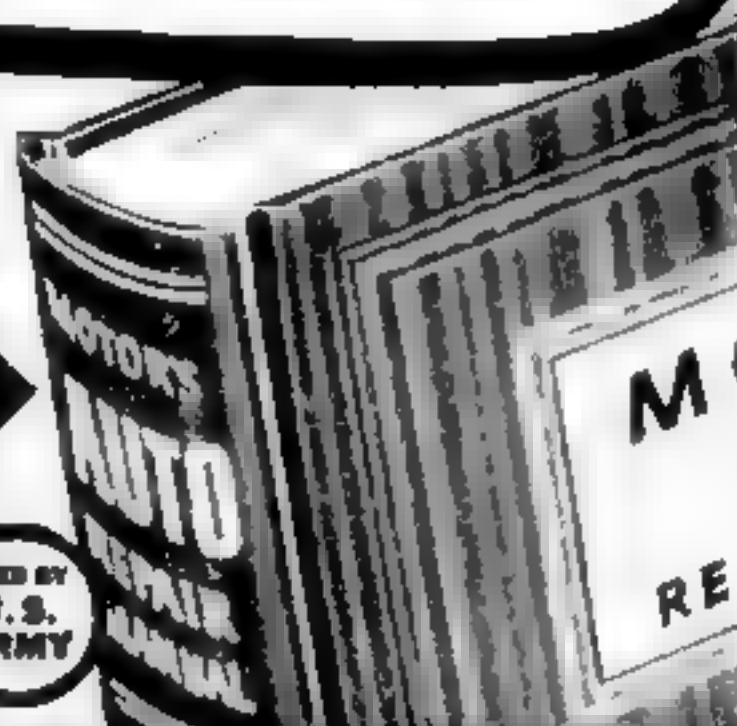
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Readers Say:

that at least two axes of rotation are possible. For the sake of the problem, a vacuum is assumed.—J. K. M., CM2/c, Port Hueneme, Calif.

Here's An Idea That Is Positively Revolutionary

WASTED energy (of which S.P.T.'s letter in October on the squeal of a pig is an example) is costing this country millions of dollars every week. I have figured out a way to stop some of this waste, and it's not silly either.

Many thousands of office buildings have revolving doors at their entrances, all turning as visitors enter and leave. So we'll simply gear up a generator to the door's axis, lead in to a storage battery, and accumulate enough juice to light up all the neon signs in the neighborhood. Of course, there may be a little extra drag for those who use the doors, but what people don't know won't hurt them, and look at the coal we'd save.—J. H. Van B., Chicago, Ill.



The newspapers just published this photograph of a CG-4A glider using its 10-foot drag parachute brake. P.S.M. cover picture showed it 10 months ago

We Consider This Routine Stuff at Popular Science Monthly

If a newspaper scoops its competitors by an hour or so, everybody on the staff, from the city editor to the copy boys, gets pretty chesty about it. What happens when a monthly magazine scoops the newspapers by a full 10 months? I ask this because on the cover of last February's *POPULAR SCIENCE* there was a picture of a U.S. glider using a parachute brake. Here it is late October—nearly a year afterward—and I have just noticed in the newspapers a photograph of the same ship with the same device printed as up-to-the-minute news. It seems to me like you guys have got something to holler about.—E. K. J., Philadelphia, Pa.

What Seabees Talk About When They're Off Duty

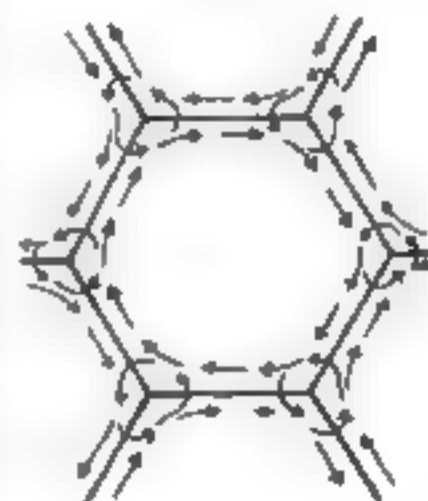
READERS SAY may be interested in the following problem, which caused considerable discussion the other night. Is it possible for a free-falling body to rotate upon more than one axis? Some claim an object can rotate on all three axes; some say two; others say that all initial impulses will resolve into a single torque, with only one axis of rotation. Experiments with a pencil seem to indicate

Wire Chicken Fence Inspires Novel Traffic Plan

Your article about postwar highways and the problems of preventing congestion (*P.S.M.*, June '44, p. 75) set me thinking. I discarded multiple-level streets (expensive), the curlicued roads and ramps that cover half an acre or more, and even the standard gridiron street plan now used in cities everywhere. I got my big idea from a chicken fence of hexagonal mesh. The drawing shows my conception of the plan in operation. With the conventional gridiron pattern, at every intersection there are three choices of direction; with this new plan, there are only two.

"Streets" and "avenues" are of four-lane width. To make a left turn, the motorist drives in the inner lane and, just after passing the intersection, makes a U turn into the opposite inner lane. No traffic lanes ever cross; they just fork, either diverging or converging. Perhaps you can pass this

idea on to someone who may make good use of it.—W. B. R., Atlanta, Tex.



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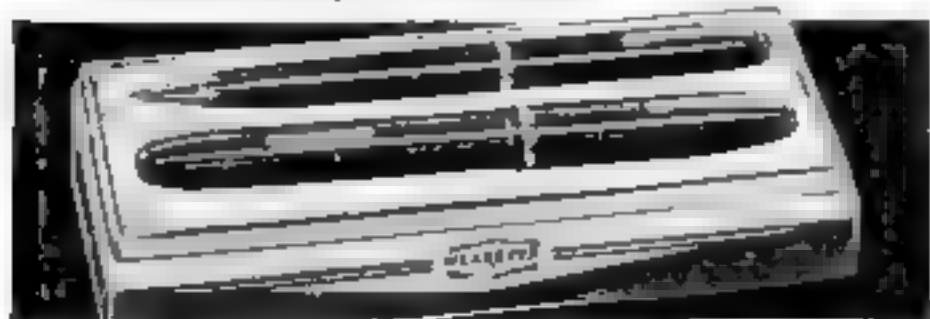
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Bathtub's Contribution to Therapeutics

I WAS interested in the first letter concerning the bathtub phenomenon, not so much from the standpoint of actual mathematics as from that of the use of the density of the water, or buoyancy, in the treatment of certain illnesses. According to Archimedes, a body will be lighter in water, therefore one immersed in water can perform acts that would be impossible in the open air, thereby using muscles that would not be used otherwise. Roughly, a man weighing 150 pounds would weigh only from six to 10 pounds in the water. (That last statement is not intended to be absolutely accurate.) Here in Hot Springs we are utilizing this principle in treating certain types of paralysis, arthritis, etc. in the therapeutic pools. This is being done in many other places in this country. Any one with a bit of mechanical ability can think of many types of apparatus that will help the patient to use muscles that he has been unable to use before.—Dr. G. B. F., Hot Springs National Park, Ark.

Can Some Reader Solve Mystery of the Pink Cow?

I HAVE been a reader of P.S.M. for about six years but have never before felt it necessary to ask the master minds of Readers Say for their opinion on a problem. Here's something that puzzles me: A cow stands outside in a rain for a while before being put inside a barn. When it is taken in, it is very wet, and the water drips off. For some peculiar reason this water is the same color as the cow. For example, we have two solid-red cows and one white one. The water that drops from the red cows has a reddish tint, and that from the white cow has a white tint. What I want to know is: what causes the cow to fade? No, I am not color-blind.—L. C. W., Norton, Va.



As one master mind to another, we're skeptical about that white "tint," although the red intrigues us. If the animals were porkers, we'd be tempted to refer to pigmentation.—Ed.



"Sunday Afternoon on the Farm" painted by Rudolf Wettlaufer

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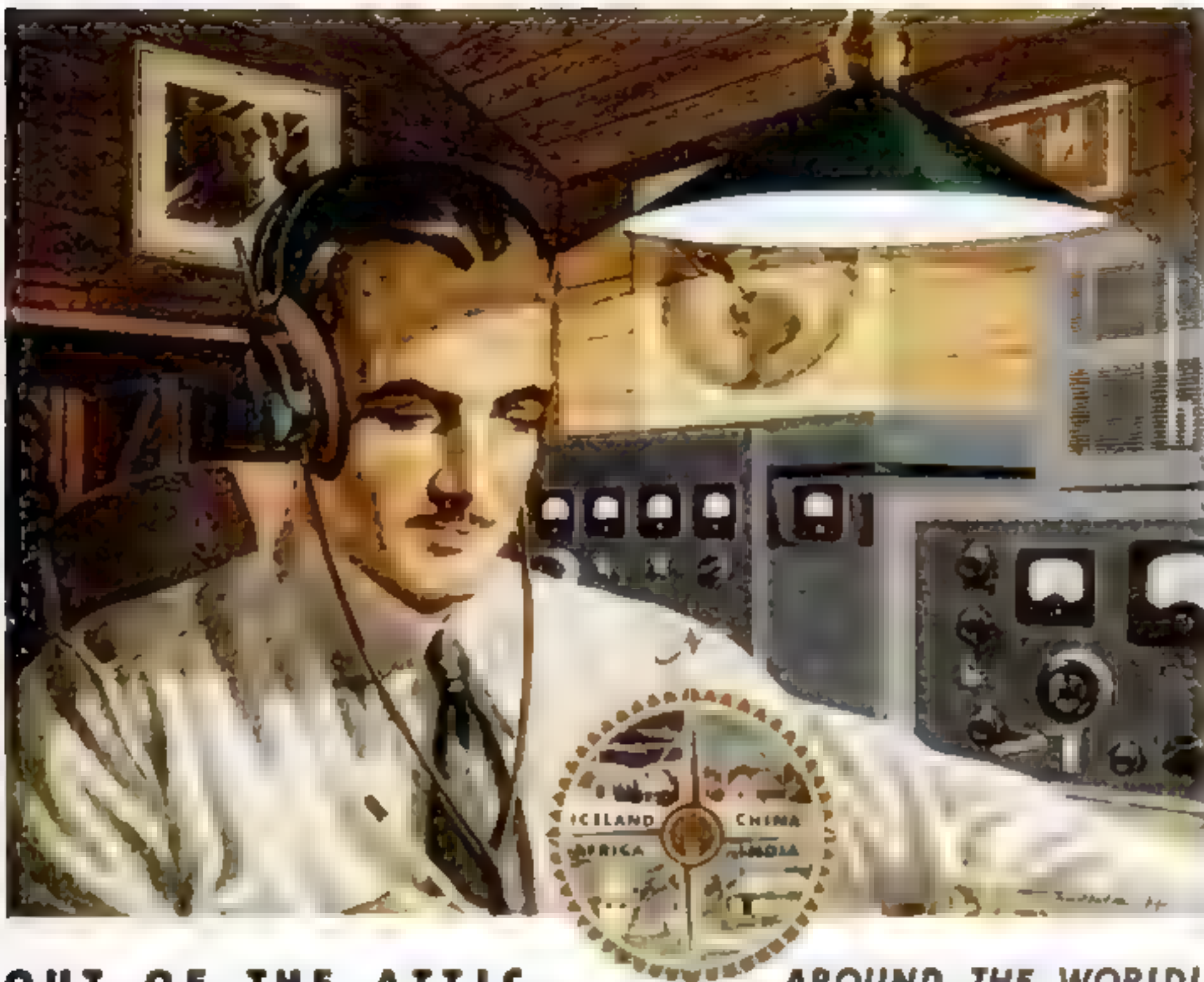
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thousands of lives have been guarded by the far-flung safety and navigation facilities of the AACs.

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I would like to have a brief explanation of the functioning of a Ouija board. I realize that one "influences" the answers considerably. Please try to give me an answer, even if the thing may be an unscientific gadget.—R. B. McC., Fort Benning, Ga.

There are several schools of thought on the Ouija. One maintains that it is merely a toy for gullible persons who kid themselves into believing that they receive messages through it; another that, although perhaps there is something in it for the psychically inclined, it has not performed in any well-authenticated instance. Others call attention to the derivation of the name (oui, French for "yes" and ja, German for "yes"), and dismiss it as simply an inanimate yes man.—Ed.



He Teaches Mathematical Wizard His Numbers

PLEASE tell Commander Aiken, of robot mathematical fame (P.S.M., Oct. '44, p. 88), that he may call the 28-figure number: 12 sextillion, 743 quintillion, 287 quadrillion, 341 trillion, 45 billion, 502 million, 372 thousand, and 98.—W. J. B., Coshocton, Ohio.

Why should he be bothered with such a detail when the robot could multiply that number by itself, extract its cube root, or figure the value of π to 700 decimal places, by merely moving a few dials? Incidentally, you're right about the name of the number, W. J. B., but we suspect that Commander Aiken could have figured it out if he had put his mind to it.—Ed.

What Was Good Enough for Eve Is Good Enough for Us

Now that they're making artificial fingerprint stain (P.S.M., Nov. '44, p. 130), why doesn't some bright chemist work out a formula for synthetic saliva for polishing pushcart apples?—D. M., Utica, N. Y.



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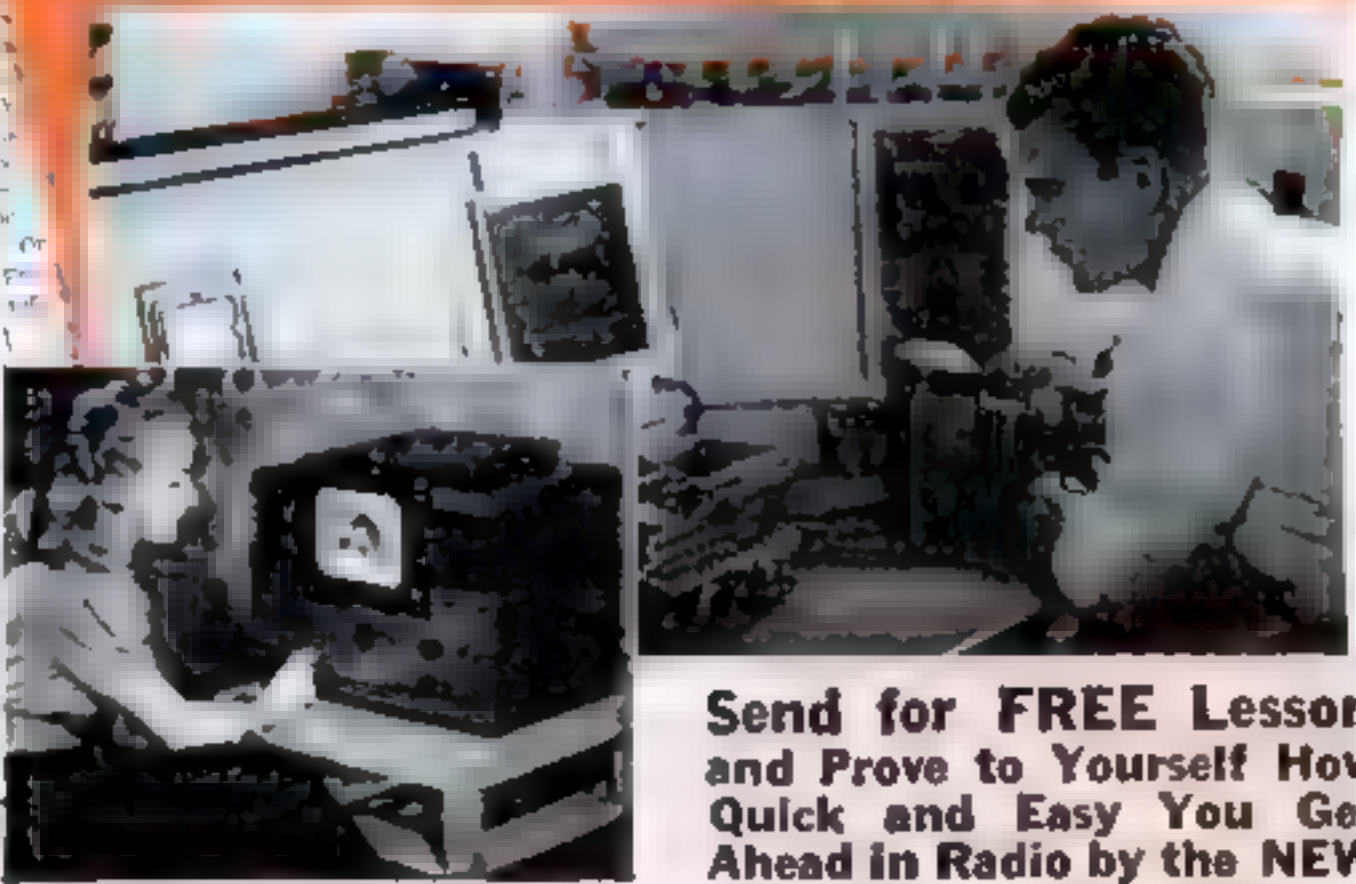


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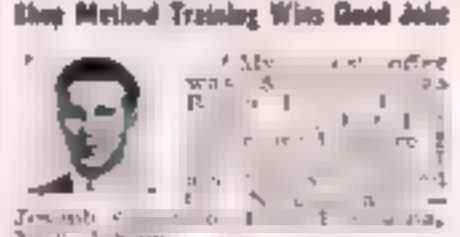


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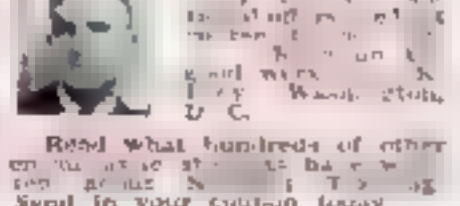
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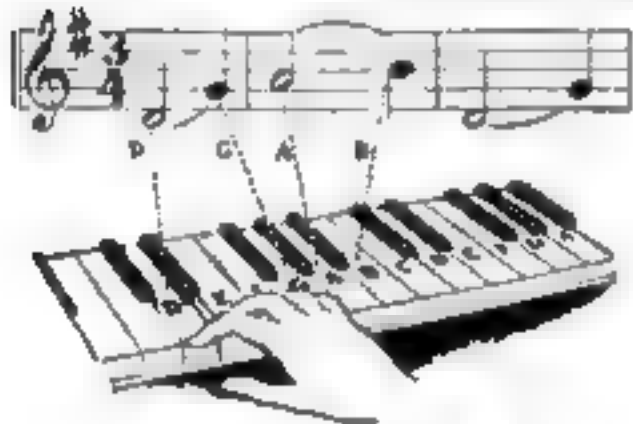
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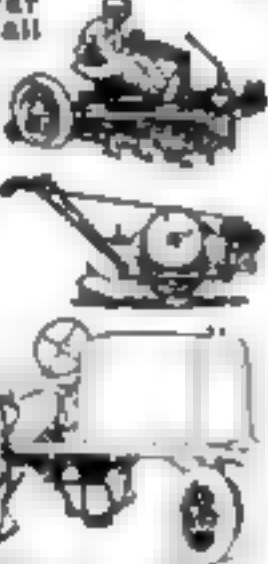
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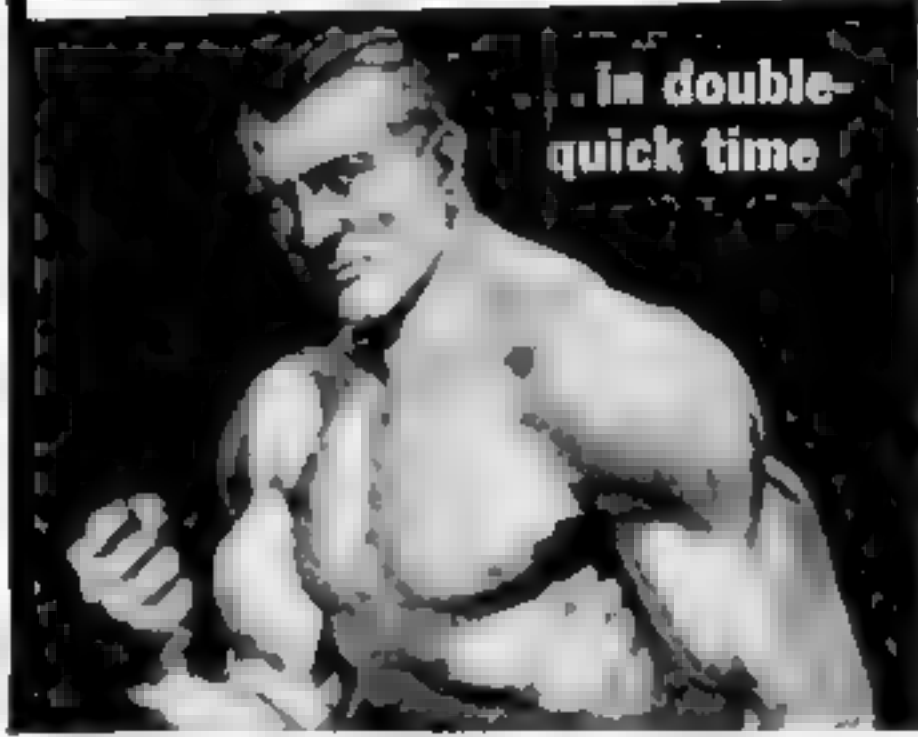
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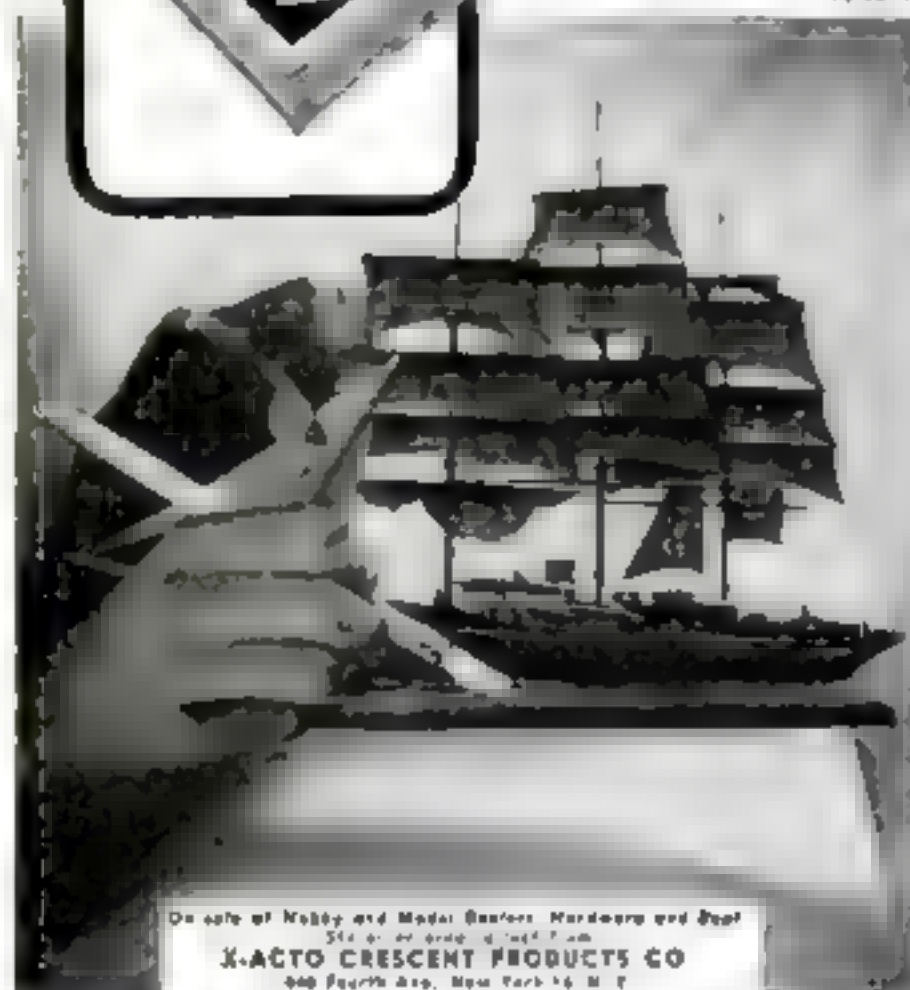
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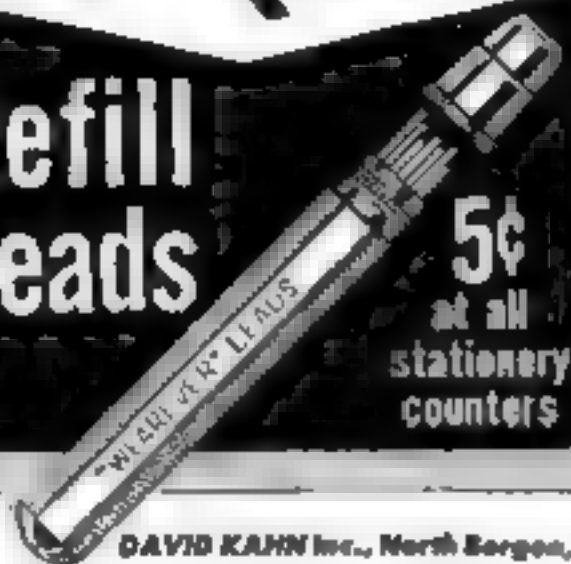
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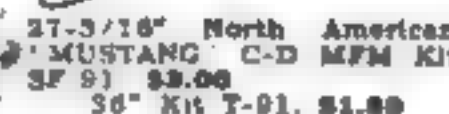


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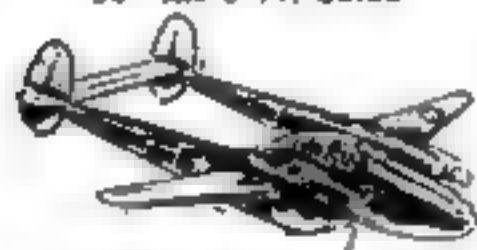
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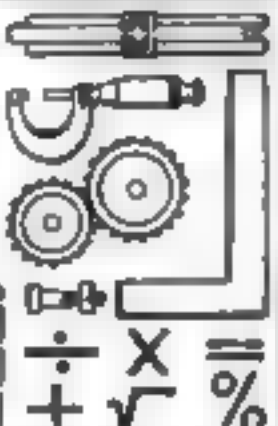
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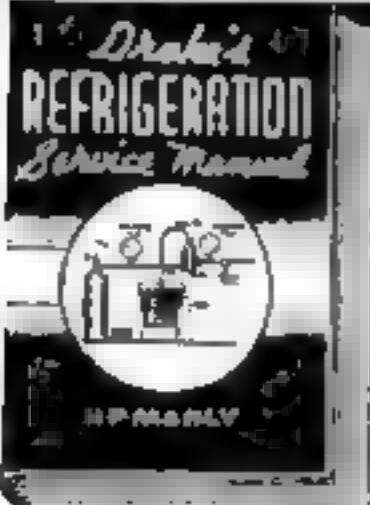
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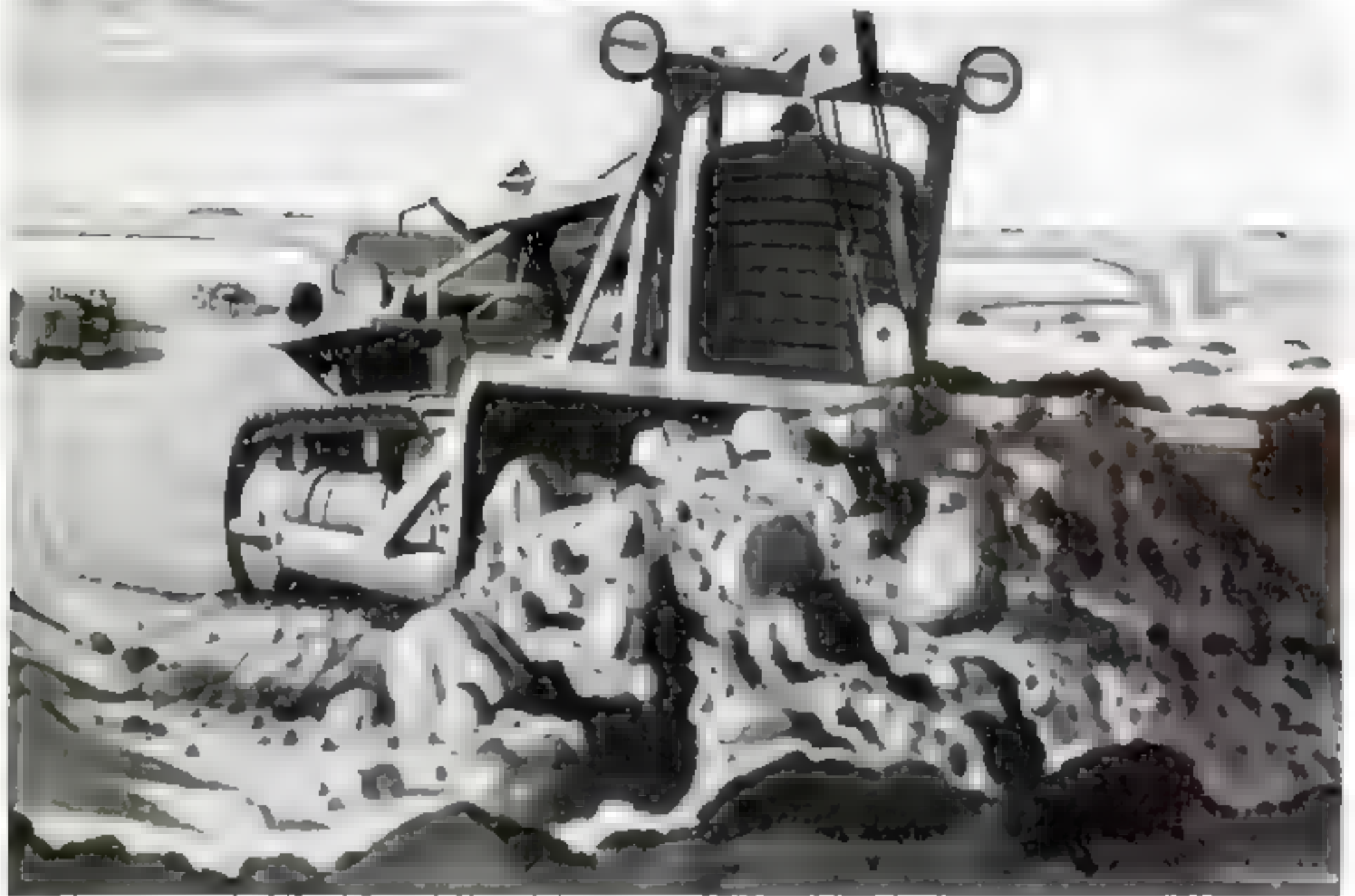
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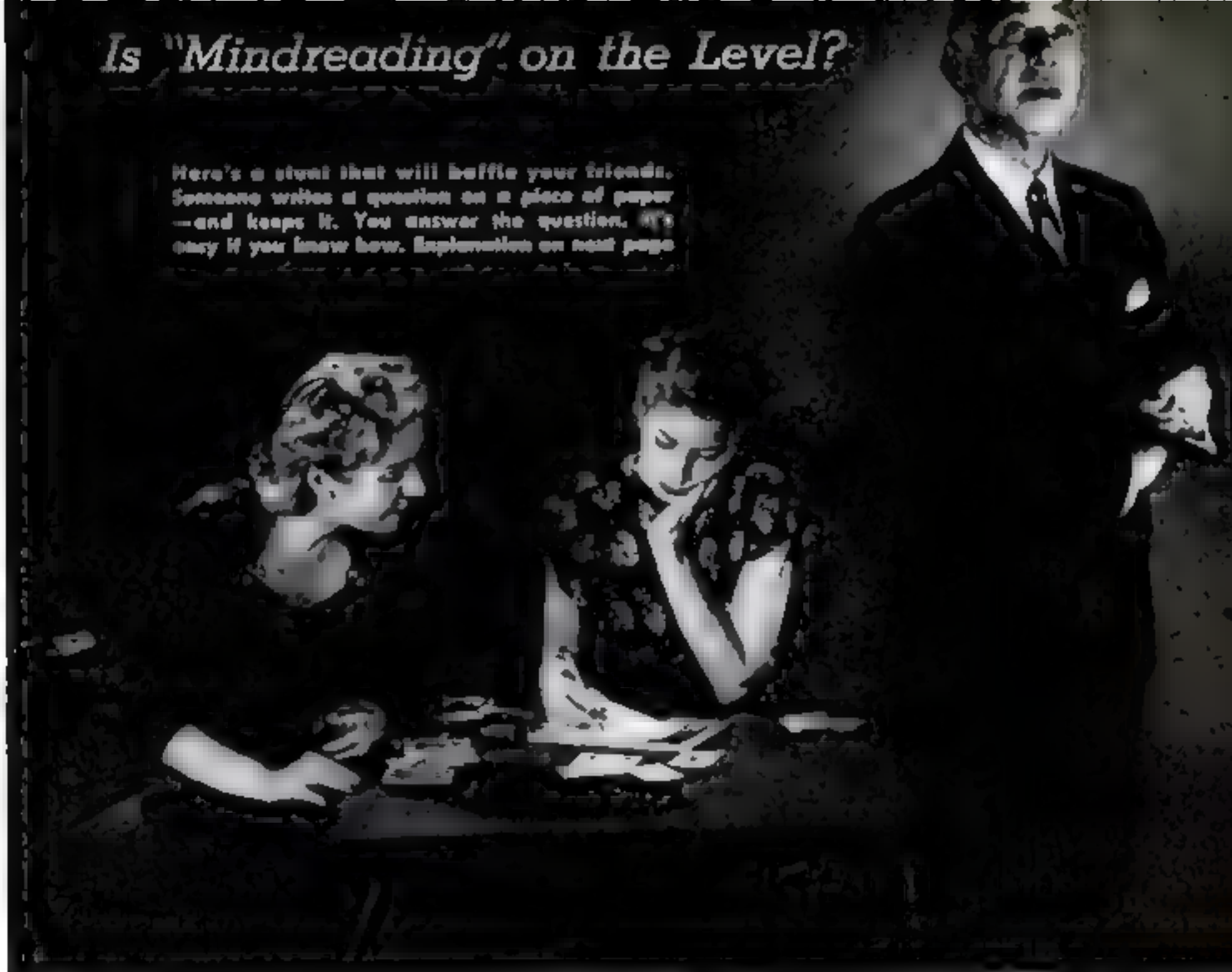
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Is "Mindreading" on the Level?

Here's a stunt that will baffle your friends. Someone writes a question on a piece of paper—and keeps it. You answer the question. It's easy if you know how. Explanation on next page.



By MICHEL NOSTRADAMUS*

THERE is no such thing as "mindreading." Let us clearly understand that in the beginning. If there were, I would not be writing this article or accepting dates to play night clubs, theaters, and restaurants. I would be sitting in an office next door to J. P. Morgan & Co. I would read the minds of the Morgan partners, and whenever they bought a stock, I would buy it too; whenever they sold one, so should I. Gone would be the days of crowded trains and poor accommodations that we "show people" must put up with. I'd never have to work again. I'd be as rich as the Morgans.

However, mindreading does pay big profits, although I assure you the partners of Morgan bank a good deal more every year. Besides paying large dividends in cash, professional mindreading also furnishes

*Michel Nostradamus lived in the sixteenth century. His astonishing predictions have come true over a period of 400 years. The author of this article, a world famous magician, cloaks himself in mystery much as the "prophet" from whom he took his stage name. He is known to us as a noted authority among the now-you-see-it-now-you-don't men, and as one whose "mental miracles" perplexed and puzzled us until we read this article.—The Editors.

You, Too, Can Be a "MINDREADER"

A few pieces of simple equipment, some easy sleight-of-hand, a glib line of "patter"—and you're all set to be a "psychic marvel."

much entertainment for friends of amateurs or nonprofessionals because it is fun, and easy to learn.

Mindreaders require no bulky apparatus. Their sole stock in trade is their ability to "sell" a "mental miracle." Learn a few of these mental miracles and you, too, will be well equipped to start a professional career, or be "the life of the party" in someone's drawing room.

The mindreader requires a little knowledge of psychology. He must always re-



HOW IT'S DONE. The trick on the previous page is done by putting a sheet of carbon paper under the cover of a magazine which the mindreader unobtrusively places under the paper on which the question is to be written. With the writer retaining the question slip, the performer then takes the magazine, casually flips the cover over, and proceeds to read the writer's mind

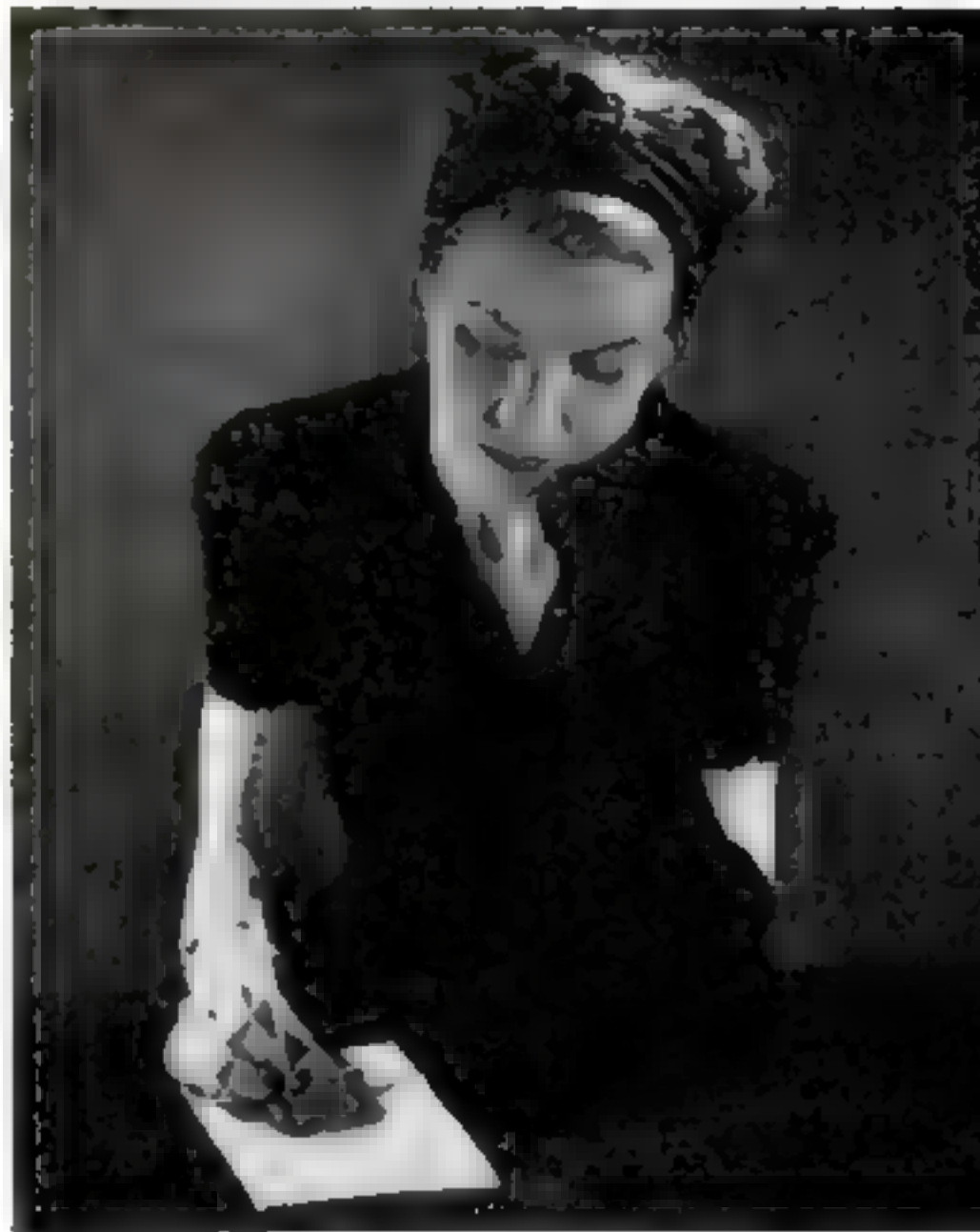
member that the spectators' minds will recognize as fact that which their eyes and ears lead them to believe. If an audience is allowed time to "reason," the best performer in the world will fall flat. Through "patter," the performer's term for interesting, fast, and yet meaningless chatter, the spectators are kept so busy listening that their brains have no chance to "reason."

A good example of a mindreader's application of psychology: a stranger writes a question on a blank visiting card. It is visibly placed in an envelope. The performer instantly burns the envelope. As the smoke rises, he says he "sees the letters forming the question taking shape" so that "I may now answer the question through my psychic powers." Without this rapid-fire patter, reason would say: (1) No individual possesses the power to read words invisible to others, (2) letters cannot be formed out of uncontrolled smoke rising from a burning envelope; (3) it can't be done—it must be a trick or an illusion.

The would-be mindreader must, therefore, keep in mind at all times that "mindreading" consists of obtaining knowledge of a question presumably written in absolute secrecy (and retained or not by the victim) and then answering it in a "mystic" manner. A glib tongue, plus plausible wording (no matter how limited one's vocabulary), which includes in the answer something

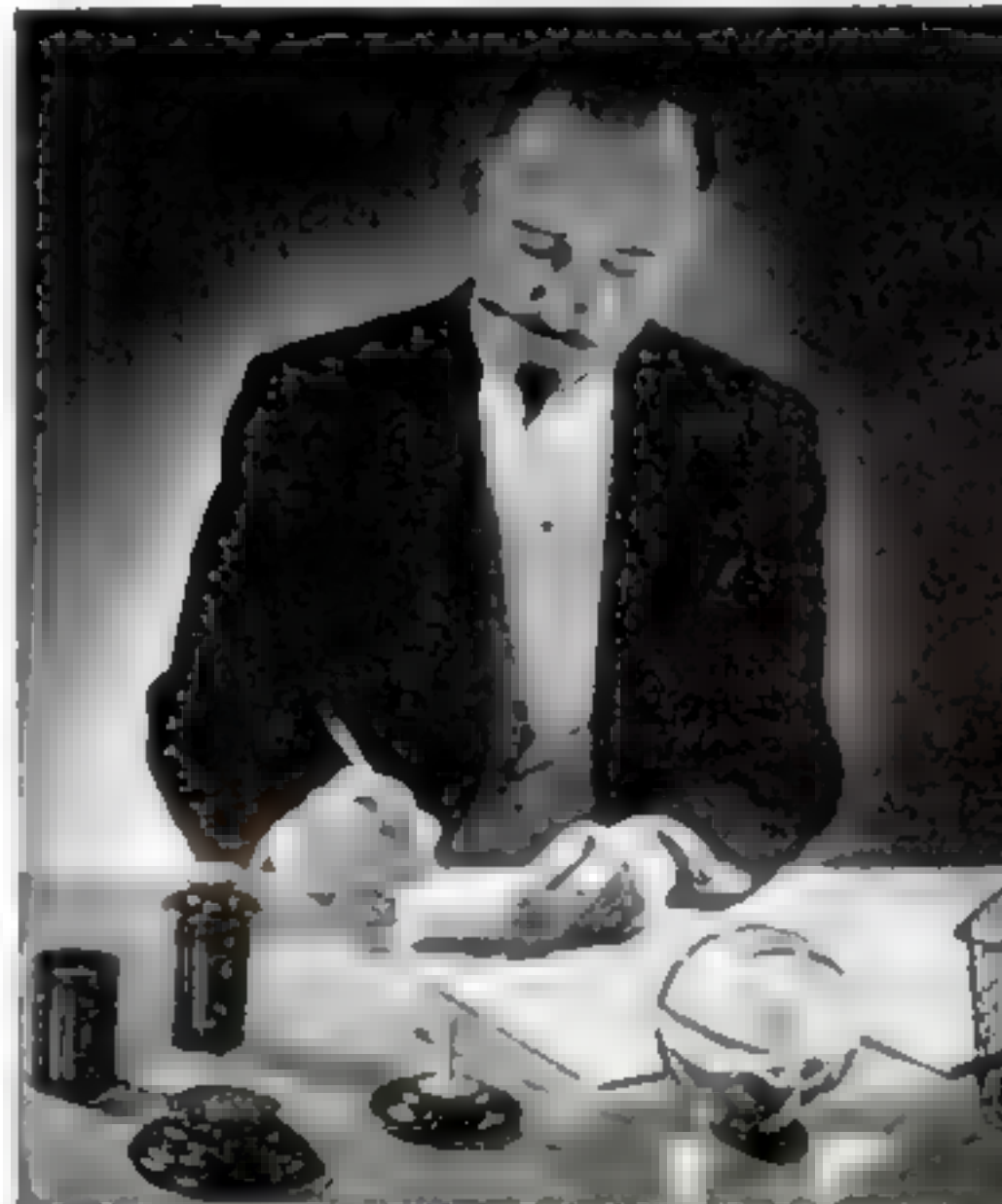
Photographs by

WILLIAM W. MORRIS and ROBERT F. SMITH

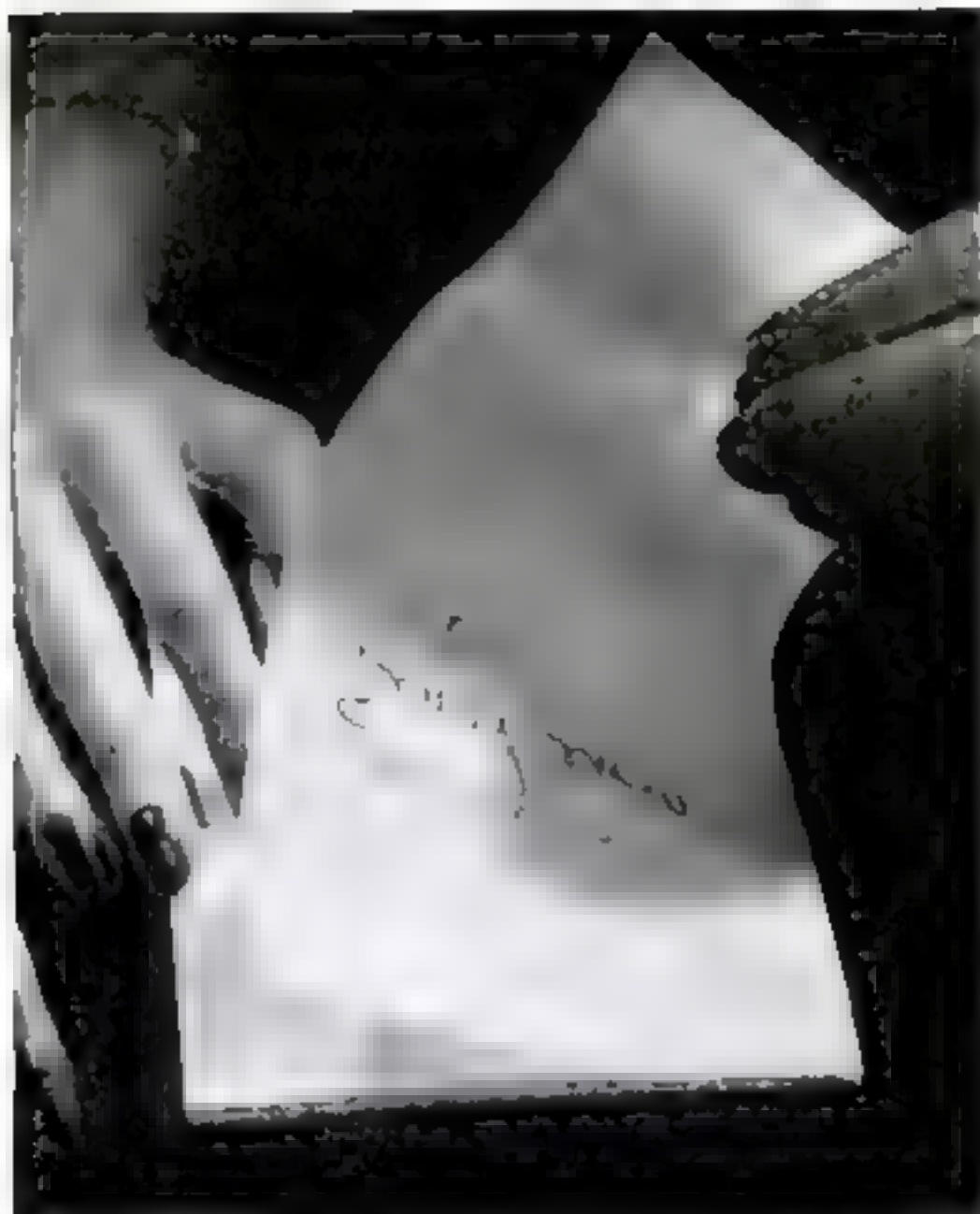


1 One method of mindreading especially suitable to the dim lights and customary confusion of a night club is what professional mindreaders call the "wax-pad" method. After the performer is introduced to the audience, waiters pass out small pads of paper

4 Backstage, he copies questions impressed on waxed sheets onto a paper which he inserts in Madame's crystal ball. Madame, meanwhile, regales customers out front with stories of her great psychic powers



YOUR EYE WHEN MADAME GAZES INTO HER CRYSTAL BALL

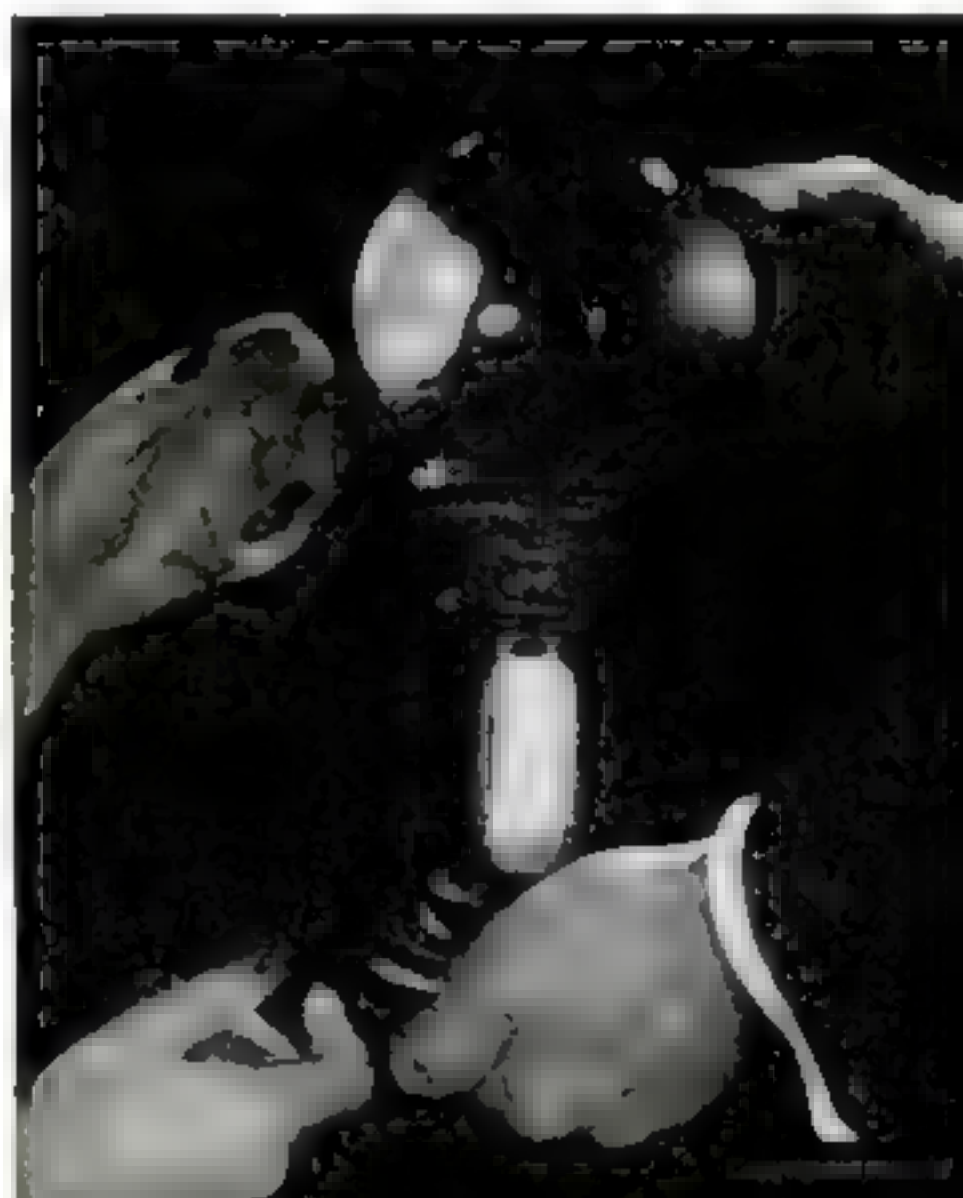


2 The people in the audience are then handed particularly sharp pencils, told to write any question they desire, initial it, tear off the top sheet, fold it, and hold it. Waiters hover around in the background, ready to remove a pad the minute its top sheet has been torn off

3 The performer's assistant, usually well mustachioed and goateed to add to the aura of mystery, now smilingly moves through the audience to collect the pads—whose second sheets have previously received a thin coating of wax

5 Assistant now presents Madame with the ball, the standard of which holds paper with copied questions. By this time, Madame's "patter" has audience "built up" to where they are beginning to believe she is the McCoy

6 Climax comes when Madame, "straining her psychic powers to the utmost," peers into ball, reads initialed questions, and then gives any answers she thinks the customers will swallow

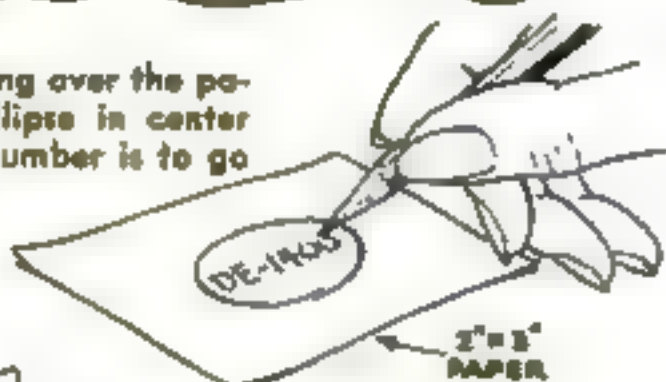


HOW TO GET HER PHONE NUMBER



A good way to "mindread" a girl's phone number is to ask her to write the number on a piece of paper, about two by three inches, telling her you promise to tear up and burn the paper the minute she hands it to you

1 Before handing over the paper, draw ellipse in center to show where number is to go



1ST FOLD

2ND FOLD

2 While she jots down the number give her the patter about your odd psychic power

3 Now have her fold the paper in half, and then in half again, as is indicated above



4 Take the paper from her, keep folded edges at top and left, then tear it downward in two



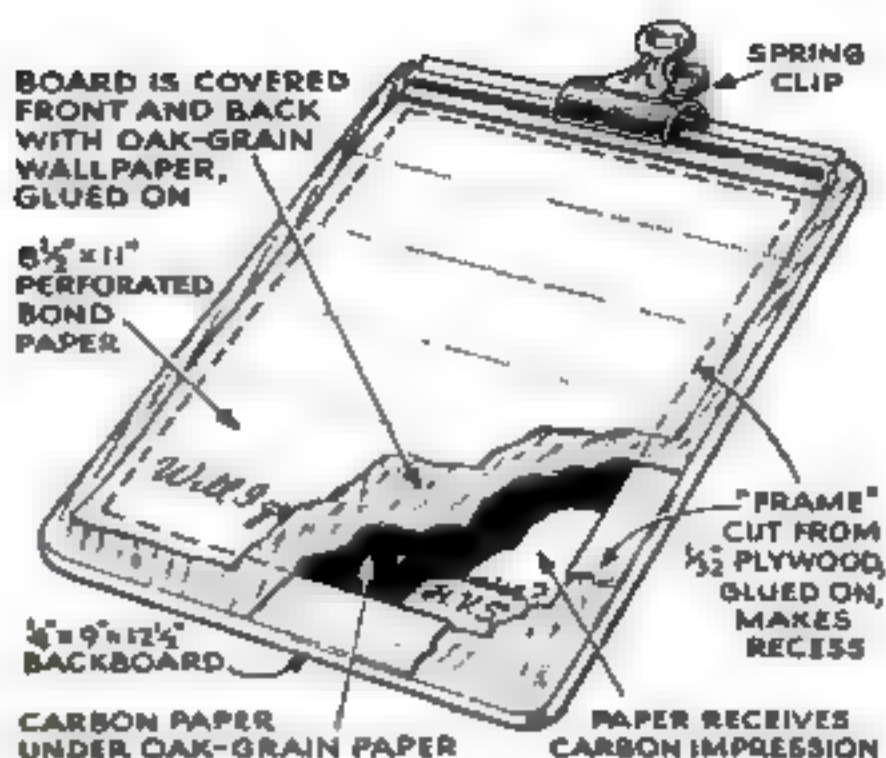
5 Put piece B on top of piece A in left hand, tear sideways, then put C on B and A



6 Slide A into palm of hand, hold B and C in fingertips, and burn



7 When you unfold A you will find you have the girl's number



"GIMMICKED" CLIP BOARD used by mind-readers has phony top surface which, while appearing to be solid wood, is only oak-grain paper glued on over recess in which lie carbon and second sheet of bond paper. After writing is done, assistant removes second sheet, furtively hands it to performer

that applies in some fashion to the person to whom the performer is speaking, does the trick. Think of some question you may ask yourself and then say 20 or 30 words aloud in reply. In advance, I'll tell you that a part of the answer must apply to someone you know, particularly if the question is about love, finances, proposed travel, marriage, divorce, or any other subject that comes under the headings of human emotion, desire, and sentimentality.

Here are some methods used by professional mindreaders. Select the one that best fits your own personality. Then develop it, keeping in mind the points brought out in the above few paragraphs.

In almost every office, school, and home are boards with a clip at the top. These boards are used to keep or file papers. They are usually about 9 by 12 inches with a large clip firmly secured at the top, by which the papers are held in place.

When used by a mindreader, the clip board usually has a piece of 16-pound bond paper, 8 1/2 by 11 inches, perforated in five places so as to make six smaller pieces when torn. The performer distributes several of these clip boards through the audience, with the request that questions be written on the attached perforated sheets. He specifically directs that the first person to write a question is to do so on the bottom perforated piece, which he is then to tear from the board before passing the board to another person in the audience. The next person is to do precisely the same thing, and the board is to pass around in this manner until all the papers are used up.

Actually, the mindreader, who is a good distance from those writing the questions,



PHONY ENVELOPE.

Holding a number of open envelopes in his hand, the performer cleverly maneuvers a person into putting a card—on which a question has been written—into an envelope whose face has been cut away. Sealing the envelope, he holds it over a candle—the meanwhile brazenly reading the question through the cut-away part of the envelope.

has no chance of seeing what is written; yet a few minutes later he gives the answers. The audience gasps, because at no time has the performer been near the papers on which the questions were written. How in the world does he do it?

The answer is very simple. The clip board is a fake! It was either bought at a commercial supply house for mindreaders, or was made by the performer himself.

Underneath the very innocent-looking front of the board, which seems so solid, is a hidden piece of carbon paper and another sheet of bond paper. As each spectator writes his question (with a well-sharpened pencil carefully furnished by the performer) the words are copied onto the second sheet of paper.

After the questions are written, the performer's assistant gathers up the clip boards, innocently takes them out of sight of the audience, quickly takes the copies of the written questions out of the hidden recess in the board, and brings them to the mindreader in one form or another. The question may be put on a desk in front of the performer just as written, or the assistant may copy them for use in some device such as the crystal ball shown on pages 68 and 69. From here on, all the mindreader needs is his glib tongue.

Here is another and more brazen-faced type of deception. The performer distributes some plain white cards (the usual 3-by-5 index card is perfect) to persons in his



audience, who are requested to write questions on these cards, place a "birth date on a part of the card for identification," and then hold the card tightly.

While the questions are being written, the mindreader chatters about the "powers developed by me beyond the realm of science."

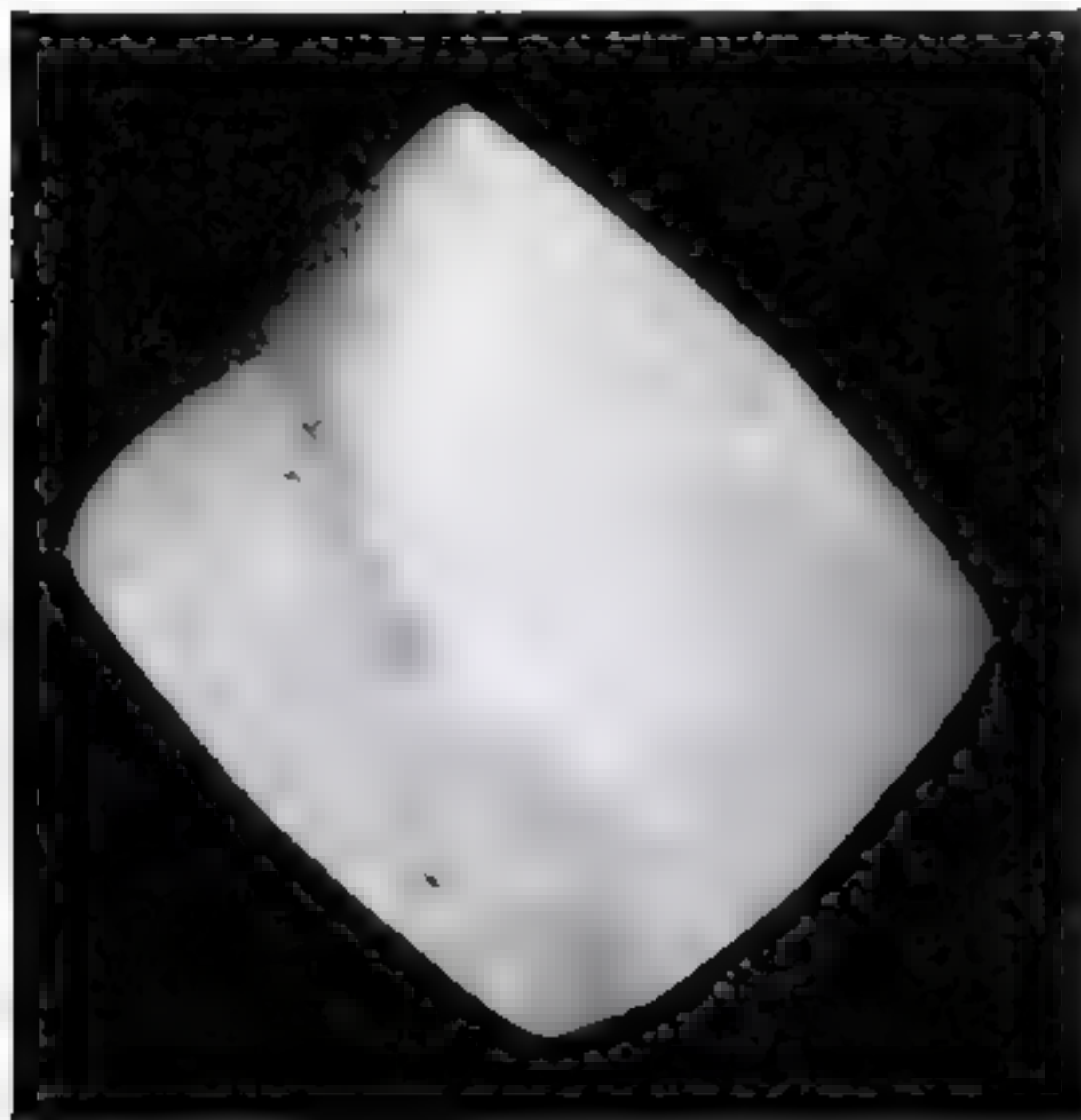
After the questions are written on the cards, the performer goes into the audience with a stack of envelopes in his hand. He says to one spectator: "Put your card in one of these (Continued on page 213/

WANT TO FIND A DIAMOND?

TRACKING DOWN



Sensational finds in many parts of the U. S. suggest rich deposits in Canada, from which samples were brought down by glaciers many centuries ago.



UNEARTHED IN A HORSESHOE GAME In a West Virginia lot, the "Punch" Jones diamond is the biggest stone of its kind found in the eastern states since 1855; one of the largest ever found in North America. It weighs 34.46 carats, and its diameter is approximately three quarters of an inch

By **HAROLD O. WHITNALL, Sc.D.**
Head of the Department of Geology,
Colgate University

THERE may be a diamond in your back yard. Bill Jones discovered one that weighed 34.46 carats in a vacant lot by his home in Peterstown, W. Va., and geologists believe that more may be found in many parts of the United States.

Jones was pitching horseshoes with his father, when his shoe clanged against a stone in the loose earth around the stake. He picked it up, exclaiming: "See, I've found a diamond!" He didn't really think so. He kept the crystal as a curio, but did not have it examined for fear he'd be laughed at.

Fifteen years later, after Jones had learned more about diamonds, he sent his pretty stone to Dr. Roy J. Holden, head

geologist at the Virginia Polytechnic Institute, who studied it and reported that it was the biggest diamond ever found in the eastern states, "a third larger than the largest previous find, the Dewey diamond, and one of the largest found in North America."

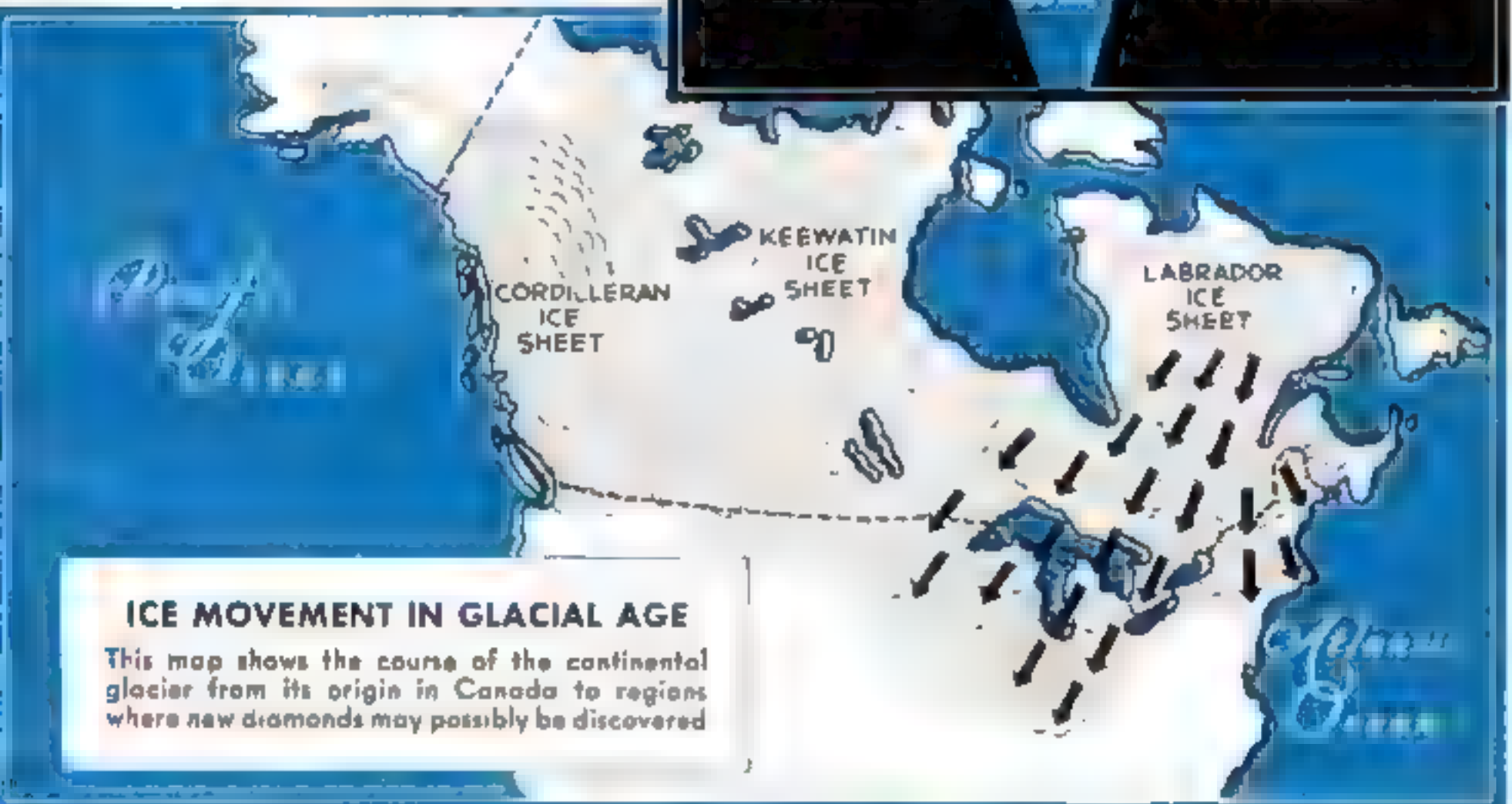
The Dewey diamond to which Dr. Holden referred was found at Manchester, Va., in 1855, weighed 23.75 carats, and once sold for \$1,800. Bill Jones's discovery was named the "Punch" Jones diamond and was exhibited recently at the Smithsonian Institution in Washington.

Thousands of other diamonds have been found in this country—some in the Appalachians, mostly in North Carolina and Georgia; others in California, in Arkansas, and in the north central states from Ohio to Wisconsin. And the announcement of Jones's luck has revived hope that some day many of these dia- *(Continued on page 232)*

NORTH AMERICA'S DIAMOND FIELD

GLACIER-GOES TO WORK ON DIAMOND "FACTORY"

Moving ice passes over a pipe, one of the entrances to a subterranean laboratory where diamonds are made and takes with it the loose upper material, which is incorporated in the glacier and carried to where it melts

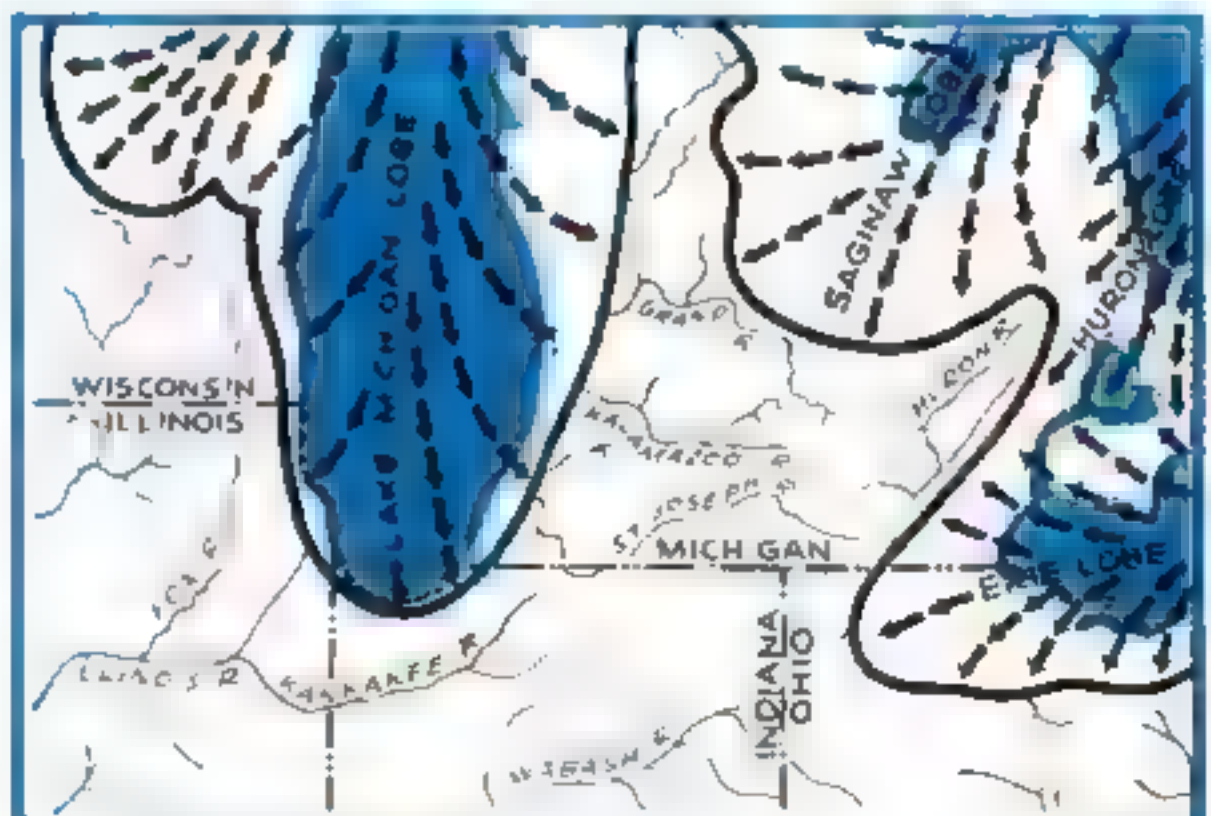


ICE MOVEMENT IN GLACIAL AGE

This map shows the course of the continental glacier from its origin in Canada to regions where new diamonds may possibly be discovered

LOOK FOR DIAMONDS IN LOBES OF GLACIERS

The curved line, beginning at the upper left of map and ending at lower right, outlines lobes, or marginal projections from the continental ice sheet. It is in the glacial debris of such lobes that diamonds have been discovered. Thousands of other diamonds have been found in the U.S.A. besides the one described in this article, many of them in the north central states from Ohio to Wisconsin. Little of the material carried south by the glacier has been searched, and some diamonds may still be hidden in the debris



Forging a Feather Pillow

A vibration absorber, simple in design and use, promises to make this a shockproof world.

HOUSES danced upon their foundations in a Michigan community. Giant steam hammers, five times the size of prewar types, were working 24 hours a day on Allied military orders. Delegations of citizens petitioned to have the nerve-racking machines shut down long enough for them to get at least a few hours' sleep at night.



Many were daytime war workers who had been forced to drive into the country at midnight and doze in their cars.

Plant officials called in Dr. C. W. Chamberlain, professor of physics at Michigan State College, and discoverer of a radical

way to kill vibration at its source. Soon the racket ended, peace returned to the neighborhood, and home-front workers enjoyed their rightful slumber. But the hammers kept right on running, and forging even more deeply and efficiently at each stroke.

What the physicist had done was to pil-

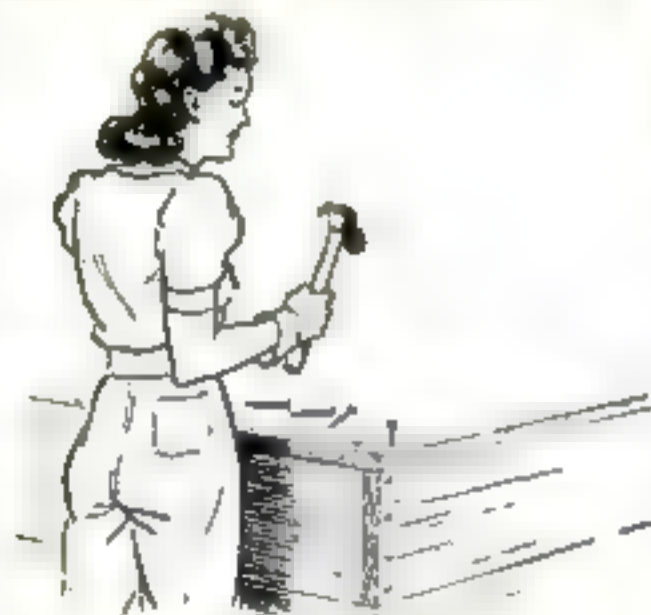
HOW ABSORBER GIVES A HAMMER MORE "WALLOP"

HAND hammers with built-in shock absorbers of the Chamberlain type ease the work of crating in export divisions of war plants. Women who have replaced men employees find the innovation especially to their liking. The special hammers relieve the strain of driving millions of nails a day, and are said to do the job more efficiently. Instead of rebounding almost instantly, the hammer remains for a comparatively long time in contact with the head of the nail. This provides fuller use of the force put into swinging the hammer, giving the nail deeper penetration at each stroke and driving it

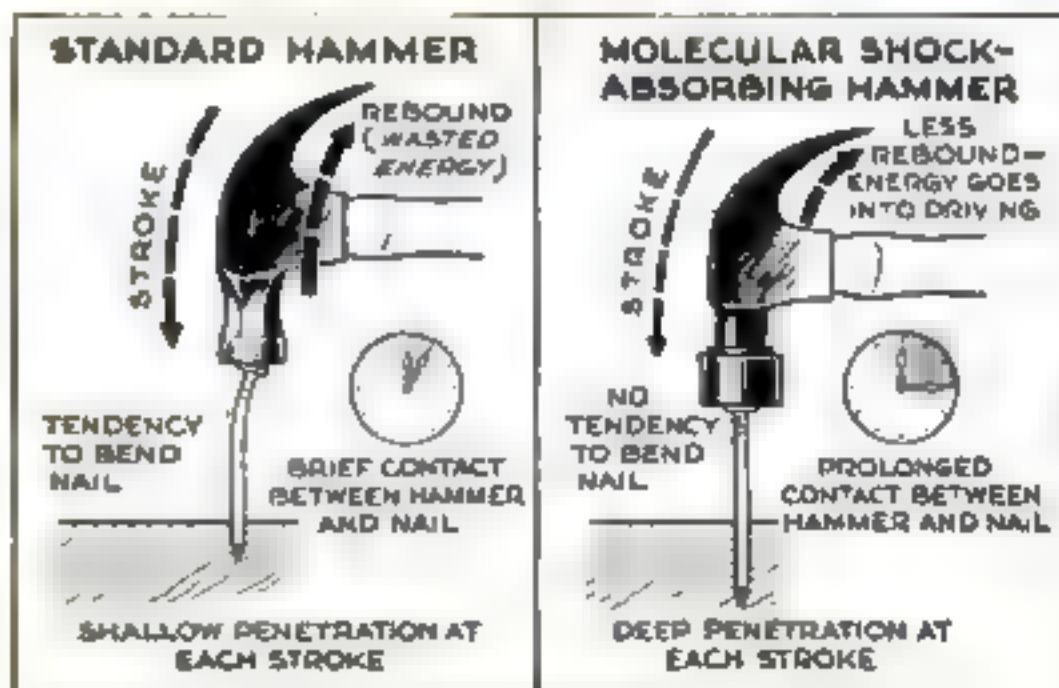
home with fewer blows. Also, because of the steady driving force, the nail isn't likely to bend. The secret lies in a stack of copper disks enclosed in the face of the hammer.



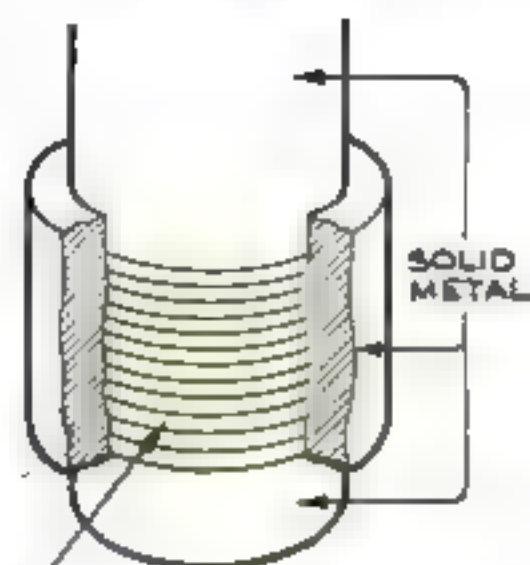
The shock-absorbing hammer as it appears disassembled and, at right, ready for use. Parts consist of tiny disks and cup to hold them on hammer's head



With the new hammer, a 110-pound woman can drive a nail home more easily and with only half as many strokes as a husky man would require using an ordinary hammer



HOW IT WORKS



In this typical assembly, the copper disks, separated by minute layers of oil and air, are packed into an almost incompressible stack, then hermetically sealed in a steel jacket

AIR FILM
1/4,000,000 IN.
THICK, HARD
AS STEEL

COPPER DISK

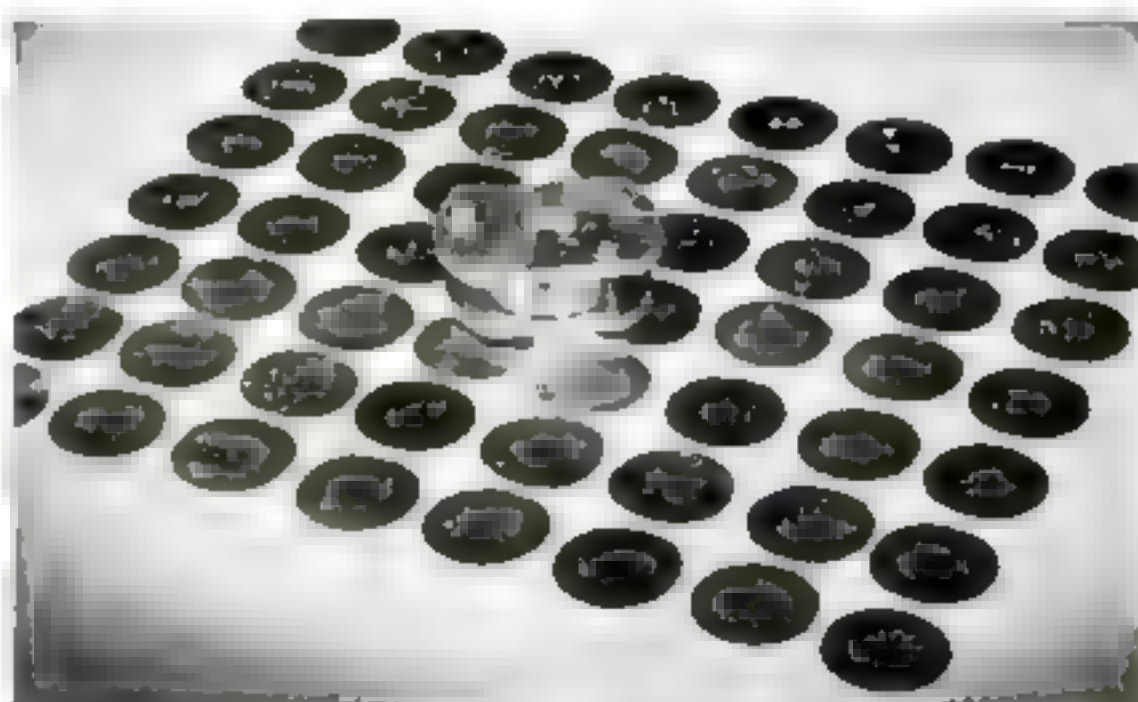


COPPER DISK



Molecular vibration absorption operates on the comparatively simple principle of converting energy from one form to another—in this case, from harmful vibration to harmless radiant heat. Compressed under a pressure of 25,000 pounds per square inch, the air between the copper disks takes on a metallic hardness, its molecules rebounding between the disks 1,500,000 times with each impact to absorb its mechanical energy as heat instead of transmitting it as a shock

low the offending machines upon what he calls "molecular vibration absorbers." These bear no resemblance whatever, either in appearance or principle, to metal springs or to resilient materials like cork, felt, and rubber. When a shock strikes, the most that these common elastic mediums can do is bounce. They cushion destructive impacts simply by spreading out the time it takes to transmit them, and not by keeping vibration from passing through. In contrast, Dr. Chamberlain maintains, the shock absorb-



Here the copper disks of a molecular shock absorber (center) for a marine engine are spread out to show the great area of its shock-absorbing surfaces. The disks are about 1 1/4 inches in diameter

WAR JOBS THE MOLECULAR SHOCK ABSORBER DOES



MACHINE GUNS lose a lot of their kick when a tiny absorber (in glass tube) is placed in the recoil mechanism. Copper disks of this absorber are only 5/16 of an inch in diameter. Another use for the absorber is in couplings which prevent vibration from passing from a plane's gearbox shaft to its propeller shaft



A



B



C

AIRPLANES. Comparison of the two absorbers at lower left shows the ability of the molecular type to retain its original shape even under the hardest usage. A resilient plane-engine shock absorber (A) is shown at (B) having lost its shape and most of its "bounce" after only 10 hours of service, while the molecular absorber (C) shows not the slightest indication of acquiring a "set," or permanent misshapeness, even after 100 hours of practically the same usage



People in a defense area found they couldn't sleep because of the terrific vibration from a powerful steam hammer near by



Usual "cushions"—which soften on impact only by "spreading it out" over a longer period of time—would not have eased up the shocks adequately



Solution came with installation of huge molecular vibration absorber under steam hammer's "saw block." Besides protecting the forge plant and near-by city, absorber guards the hammer's anvil, which often cracked under the impact



INVENTOR of the new vibration absorber is Dr. C. W. Chamberlain, professor of physics at Michigan State College, who first became interested in the vibration problem when the engine for a streetcar cable system began to jolt his house

of the Chamberlain type, examined after 100 hours of the same service, retained exactly its original shape. It is characteristic of these shock absorbers that they do not acquire a "set," or permanent misshapeness, under hard knocks.

Copper sheets in representative samples range in size from tiny disks $5/16$ of an inch in diameter up to rectangles three by six feet, in massive sections weighing 300 pounds apiece. The smallest size serves in the

er he has invented completely converts the mechanical energy of vibration into heat.

Hermetically sealed in a welded metal jacket, a typical model consists of 50 thin disks or sheets of copper, coated on both sides with a film of oil five molecules thick, and arranged in a stack. When this stack is compressed under a pressure of 25,000 pounds to the square inch, it becomes a seemingly solid piece of metal, about a quarter of an inch thick. Yet between adjacent copper sheets, held in place with the aid of the oil films, there remains a layer of air about a quarter of a millionth of an inch in thickness.

On paper, the result should be a shock absorber as hard as steel, yet as soft as a feather pillow. Practical trials confirm the paradox. Conventional mountings for airplane engines have employed oblong blocks of rubberlike material, so resilient that they may be bent double in the hand. Pounded by 10 hours of service in flight, they become squashed to a fraction of their former thickness. But an unbending vibration absorber

recoil mechanism of machine guns. The larger, installed beneath a mighty steam hammer, absorbs the shock of a 15,000-pound steam-driven ram hitting a 300,000-pound anvil. Not only does the shock absorber protect the surrounding city from resulting "earthquakes," but it also safeguards the hammer and anvil, which formerly were frequently cracked by the terrific impact.

A universal joint, fashioned by equipping a standard flange coupling with Chamberlain shock absorbers, prevents gear vibrations from passing from a gearbox shaft to a propeller shaft. Vibrationless push rods, for high-speed valve mechanisms, now employ a piston and cylinder enclosing a molecular vibration-absorbing assembly.

Wherever delicate operations need to be shielded from external sources of vibration, Chamberlain-type absorbers again come into play. Reconnaissance and gun cameras for airplanes are kept from being shaken out of focus by tiny shock-absorbing blocks. Absorbers only a few inches square permit



IN PRECISION TOOLS, whose accuracy may be reduced by vibration, the new shock absorbers have found an important use. This vibrationless finger support, its copper disks enclosed in the steel jacket near the tip, has been designed to replace the guide wheel (shown at upper right) of a milling machine that profiles the blades of airplane propellers by following the outline of a master blade



vibrationless operation of precision machine tools. In a Detroit plant making airplane engines for America and Britain, machines producing pistons vibrated so seriously that production halted for 10 days. It resumed after six molecular shock absorbers were placed beneath each machine. In another application, a vibrationless finger support transfers the profile of a master airplane-propeller blade to a blank being cut by a milling machine, so smoothly that priceless time is saved in finishing operations.

Multidirectional shocks meet their master in a more elaborate shock absorber for marine engines. Besides a stack of disks that

nullify direct impact, two coils of copper ribbon oppose torsional or twisting forces.

Production for war needs currently taxes the capacity of the Chamberlain Laboratories, which manufacture the molecular shock absorber. Later, its manifold uses are expected to appear in everyday life. Shock-absorbing hand hammers, whose industrial use is described elsewhere in this article, are likely to find favor with the handy man—or woman—of the house. And vibrationless supports for typewriters and business machines suggest postwar applications so obvious that they may come to be taken for granted.—CLINT DUNATHAN.

ENGINE MOUNTING THAT TAKES SHOCKS FROM ANY DIRECTION



Mountings employing the new molecular vibration-absorbing principle have also been designed to protect the engines of our fighting and cargo ships. Shown at left is one of the marine types which can guard an engine from shock irrespective of the direction from which the shock may come

Secret of the absorber lies in the conventional stack of copper disks (lower left) which is used to dissipate vertical shocks, and also in two coils of copper ribbon (below) which, by acting in opposite directions of rotation, are able to oppose any torsional shock the engine may suffer



DISKS ABSORB VERTICAL SHOCK

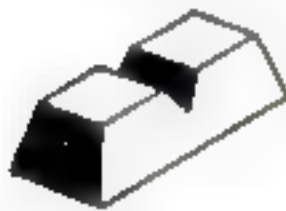


COILS ABSORB TORSIONAL SHOCK



OPTICS

TOUGHNESS is added to safety-goggle lenses by the American Optical Co., by heating the lenses and then quickly cooling their surfaces, increasing their strength 400 percent. Polarized-light test above reveals proper toughening.



METALLURGY

THREE COMMON METALS—copper, tin, and zinc—were combined by George W. Jernstedt, research engineer in the Westinghouse Meter Division, to originate a plating process that protects instruments against



CLOTHING

WATERTIGHT SLIDE FASTENER for war-time use on exposure suits, and with many applications to aircraft equipment, has been perfected by the B. F. Goodrich Co. Built-in pressures in the specially devised overlapping rubber flaps create a strong seal against any pressure the strength of the fastener will stand. The new device is airtight as well as watertight.



corrosion and tarnish. "Bright alloy plate," as it is called, must meet a standard test of 200 hours of continuous salt spray without signs of corrosion or accretion of salt particles. This nonmagnetic coating, 1/15 the thickness of human hair, improves the conductivity of current-carrying instrument parts. Below, copper bands are withdrawn from plating bath (left), and test is made of metal concentration in the solution.





ELECTRONICS

TWO-MILLION-VOLT X-RAY TUBE.

Before Pearl Harbor, Navy men wanted to know why new 10,000-ton cruisers returned from sea trials with sternposts broken. Radium shadow pictures through duplicates of the steel castings revealed incipient flaws that would have caused instant rejection. Now a precision 2,000,000-volt X-ray tube, designed to take radiographs through 12 to 16 inches of steel, is announced by the Machlett Laboratories, Springdale, Conn. Because it uses a "point source" of X rays, the machine is claimed to give exceptionally clear definition of air bubbles and other flaws. Using direct current from a whirling-belt generator of the Van de Graaff type, the tube employs 180 glass-to-metal sections to bring the electrons to top speed. Electromagnetically brought to a focus, the 2,000,000-volt electron beam impinges on a gold target of 2¼-inch diameter, and X rays emerge on the opposite side. Diagram shows operating principle.



CHEMURGY

PEANUTS INTO CORK is a transition that has been made by Herman M. Kullman, Atlanta, Ga., inventor of a cork substitute consisting of 20 to 40 percent of peanut-hull or other vegetable fibers ground into a meal and then milled with a liquid. It can be made into rods or sheets, or poured into crown caps such as are used for sealing bottled beverages.

COWS'-MILK LACQUER has been invented by Paul Watson, associate chemist of the Bureau of Dairy Industry, as a substitute for the tin coating on cans used for milk and cream. Lactic acid, made by fermenting milk sugar in whey, is an important ingredient, and there is a small proportion of castor or some other vegetable oil. Shortage of tin for milk containers prompted the development of the new lacquer, but it has been found suitable for many other uses, including the impregnating, gluing, and molding of various articles.



CHEMISTRY

SALT-WATER POWDERED SOAP, developed in the laboratories of the Bureau of Ships, saves space, fuel, and fresh water in the U. S. Navy. Through its use the vessels are able to get along with fewer laundry materials, and less fuel is required for the distillation of water. The new soap makes laundry work easier because the need for alkali builder and "sour" is eliminated, and separate bluing and bleaching operations are reduced.

DECEMBER, 1944





Meet The Invader

It's our fastest bomber—the hard-hitting, low-level attack plane that is taking over the job formerly done by the famous Havoc.

ANOTHER swift little giant joins the Army's big team. It is the A-26 Invader, super-successor to the A-20. An official Army announcement terms it the newest, fastest, deadliest attack bomber of the AAF. Swifter than most production fighters, the Invader can strike from treetop altitudes, presenting only a flash to ack-ack fire.

Unusual versatility enables this speedy and nimble weapon carrier to be used as a fighter, bomber, night fighter, torpedo, de-

stroyer, strafing, or attack plane. In all respects, the A-26 surpasses its famed predecessor.

Invaders have been in production many months at plants of the Douglas Aircraft Co., in Tulsa, Okla., and Long Beach, Calif., and are already in action on the fighting fronts.

American pilots soon learned that in the A-26 they had a far better plane than the Nazi Stuka dive bomber had ever been. When the Stuka ended its career on the Western



This is the view that startled Japs get of the new A-26 attack bomber as it swoops in for the kill. Power plus clean lines make it our fastest bomber. Note square-cut tail (left) and boxlike fuselage

Front and England in 1942, the first A-26 was ready to fly. The Stuka, and our own A-24's, died because they carried inadequate defensive armament. We needed either dive bombers or a good, fast light bomber packing heavy firepower for attacking at low altitudes. The AAF had developed attack aviation earlier, up to a point, with the Curtiss Falcon and the A-17.

Early in the war, A-20's and British Beau-fighters proved many times that they could bomb and strafe enemy bases and get home, fighting their way back when necessary. Then the A-36, a low-level Mustang, hit the Germans in Sicily. B-17's undertook low-level attack missions in New Guinea, B-25's smashed Jap shipping with 75-mm. guns, and B-26's shattered the Germans with a dozen guns on sneak raids across the English Channel.

The Invader, the Army fondly hopes, combines the virtues of all these work horses, plus a few tricks all her own. For it was specifically designed, literally from the ground up, both to meet the requirements of mass production and to fight anywhere in the world, attacking naval vessels, landing parties, wharves, towns harboring enemy troops, antiaircraft emplacements, supply dumps, tanks, and troops. And it can carry any *(Continued on page 228)*

The squarish tail of the A-26 rides high. Main landing wheels retract into the nacelles; the nose wheel turns to lie flat in the fuselage, thus lessening the drag



Jet action of the four-part exhaust stacks pointed backward through the cowl clears burned gases out of the exhaust manifold. By relieving the pressure ordinarily built up here, they increase the output of the two engines by several hundred horsepower

The wide-view, quick-release canopy gives the pilot excellent visibility, important when Invaders fly in tight formation against the enemy fighters





ALLEN RAYMOND, noted war correspondent, has been covering the bitterly contested Allied advance in Italy. When we cabled him for a front-line report on the Browning Automatic rifle, this was his reply:

It Sure Is a Rugged Gun

THROUGHOUT the long, hard, bitter war that Gen. Mark Clark's Fifth Army fought against the Germans on the Italian peninsula through most of 1943 and 1944, there was one group of American infantrymen who made themselves particularly hated and feared by the enemy. These were the "BAR boys," who handled the Browning Automatic Rifle. Conversely, the "BAR boys" became the doughboys' darlings—not because they were any braver than their fellows, but because they brought into action a gun that proved itself the most effective infantry weapon extant for close-up fighting in the rugged Italian hills.

In some ways this was a strange phenomenon, since the Browning Automatic Rifle was no new weapon, and it was holding its own in a war where the ordnance experts of every nation were continually pushing newer and newer weapons into the fray. It was a war in which the 105-millimeter howitzer had replaced the famous old French 75 as the artilleryman's sweetheart. Men were carrying M-1 carbines in place of the old Colt .45 pistol, and the Garand rifle had virtually retired the old reliable Springfield '03. New weapons such as the tommy gun and the bazooka were killing the enemy from Salerno to Leghorn.

Yet here was this Browning Automatic Rifle, rather a heavy, cumbersome, slow-firing weapon of the vintage of 1918, build-

ing itself an almost legendary reputation among our foxhole dwellers. Why? Because it was a deadly, accurate killer at both long and short range, as numerous citations of our heroes will show.

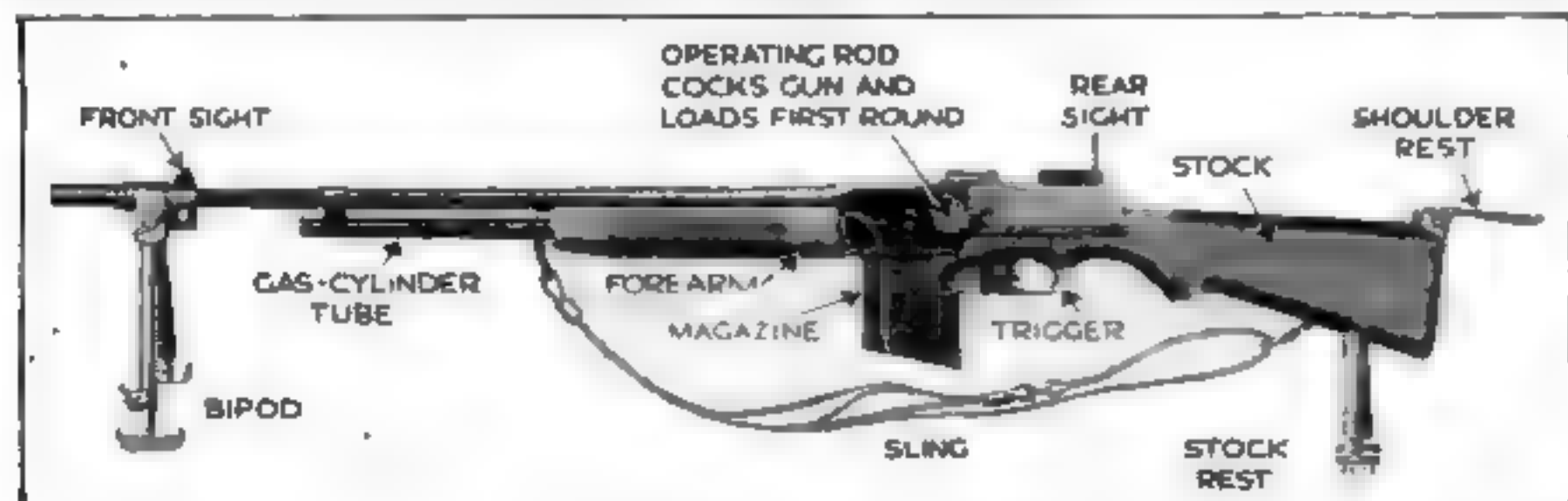
Take this one, for example:

Pfc. Alton W. Knappenberger, of Spring Mount, Pa., received the Congressional Medal of Honor for his work with a Browning Automatic. The citation read as follows.

"When a heavy German counterattack was launched against his battalion, Private Knappenberger crawled to an exposed knoll and went into action. An enemy machine gun 85 yards away opened fire and bullets struck within six inches of him. Rising to a kneeling position, Private Knappenberger opened fire on the hostile crew, knocking out the gun, killing two members of the crew, and wounding the third. While he fired, two Germans crawled to a point within 20 yards of the knoll and threw potato-masher grenades at him. Private Knappenberger killed them both with one burst.

"Later a second machine gun opened fire upon his exposed position from a distance of 100 yards and this weapon also was silenced by his well-aimed shots. Shortly thereafter an enemy 20-mm. antiaircraft gun was directed against him and again Knappenberger returned fire to kill one member of the hostile crew. When his ammunition became exhausted, he crawled

THE "BAR." In Ordnance language, it's called the Browning Automatic Rifle, caliber .30, M1918A2, and described as an air-cooled, gas-operated, magazine shoulder weapon with bipod. With its sling it weighs about 20 pounds and takes a magazine holding 20 rounds of standard .30 caliber ammunition. Has two cyclic rates of fire, 550 and 350 rounds a minute; most effective rate is 120 to 150 per minute.





Drawings by H. O. SEIELSTAD

"As the patrol started to by-pass the mound, suddenly the silence was ripped wide open by the 'b-r-r-r-up' of a Sponaug machine gun. Our doughfeet dropped to cover and opened up. The BAR boys covered the crawling advance of the riflemen by quick bursts until their GI pals could get in to the enemy and use their hand grenades"

15 yards forward through steady machine-gun fire, removed rifle clips from the belt of a casualty, returned to his position and resumed firing to repel an assaulting German platoon armed with automatic weapons. Private Knappenberger's intrepid action disrupted the enemy attack for over two hours."

The citation did not tell it, but Knappenberger and his automatic killed more than 40 Germans during a few days of that action.

Take a look at the BAR. It's a bit old-fashioned in its square-cut lines, quite heavy, and its ammunition load wears a man down in uphill work, of which there was plenty in Italy. Moving into action with this gun and 18 magazines of ammunition, each BAR boy is carrying some 46 pounds of death-dealing equipment, besides his personal gear, such as pack, rations, and canteen. It is a considerable load. Each BAR boy, as the fighting went in Italy, usually went forward with an assistant who had

another 18 magazines of ammunition, as well as a Garand for his own personal fighting. This assistant acted as liaison man with squad or platoon leaders, and was a BAR boy in his own right, ready to replace his partner should BAR boy No. 1 become a casualty. Some organizations used a third man in the team, an ammunition carrier.

Up near Cisterna, in the final days of the battle for Rome, there was a slow-spoken, quiet Texas ordnance sergeant, whose hands flicked over a battle-worn BAR as he disassembled it, opining, "It sure is a rugged gun." The one he had on his bench had seen plenty of service, and from its low serial number, 85005 Winchester Repeating Arms Co., was far from new.

This gun had come to the sergeant for a new rear-release and stop spring, and would be back in action in an hour or two. This would be the type of mission that gun would be used on:

Company X of *(Continued on page 218)*

Two Planes That Open a New World for Postwar Private Flyers

Top winning entries in the \$5,000 Popular Science contest represent to an amazing degree the preference of professionals and amateurs alike for a four-place, twin-boom pusher.

FOR the first time in the four-decade history of private flying in America, a clear picture of exactly what the public would like to see in airplane showrooms—abutting Automobile Row—when the peace is won has been brought into relief.

POPULAR SCIENCE MONTHLY in June announced a personal-airplane design contest. It was called "The Plane You'd Like to

Own." When the books were closed on the competition, which ended on September 30, entries had been tabulated from all the 48 states and ten foreign countries. They numbered 3,345.

And this is what they reflected in the public's tastes:

General characteristics: safety, comfort, good looks, practicability and performance.

Specific characteristics:

Spinproofing, and the incorporation of such safety devices as slots (to insure all-around control under stall conditions) and flaps (for lower landing speeds).

A wing attached to the bottom of the fuselage for maximum visibility.

Twin booms supporting the tail surfaces and enclosing a pusher propeller, automatic insurance against Junior's walking into the

THE JUDGES—ALL AIR-MINDED EXPERTS

CITIZENS for their special qualifications, the following experts (reading left to right in the photo below) comprised the Board of Judges for the contest:

Roger E. Schlemmer, Chief of Aircraft Engineering Branch, Civil Aeronautics Ad-

ministration, New York City. His department passes on the practicability of all aircraft designs submitted for licensing under the Civil Aeronautics Act.

C. B. Colby (standing), Aviation Editor of POPULAR SCIENCE MONTHLY.

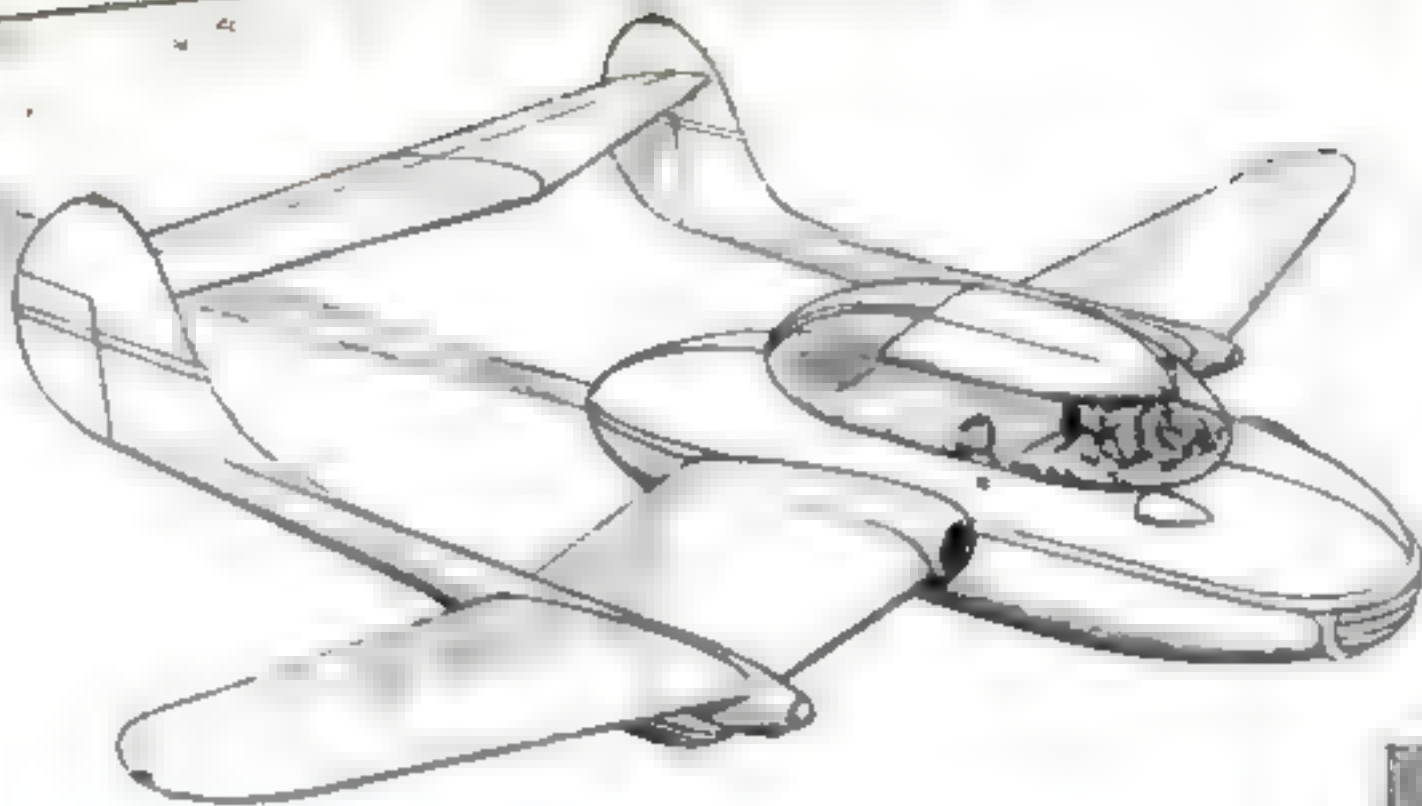
Lt. Col. Leon B. Lent, USAAF, Head Engineer, Aeronautics Branch, National Inventors Council, Washington, D. C. His department passes on all aeronautical devices submitted to the Council by inventors.

Arthur Wakeling, Assistant Editor of POPULAR SCIENCE MONTHLY.

Oliver L. Parks, President of Parks Air College, East St. Louis, Ill. One of the country's outstanding aviation educators and exponent of the Airparks program for thousands of landing strips and air parks to be built for postwar private flyers.

Col. Earle L. Johnson, USAAF, National Commander of the U. S. Civil Air Patrol, Army Air Forces Auxiliary, Long Director of Aviation for the State of Ohio.

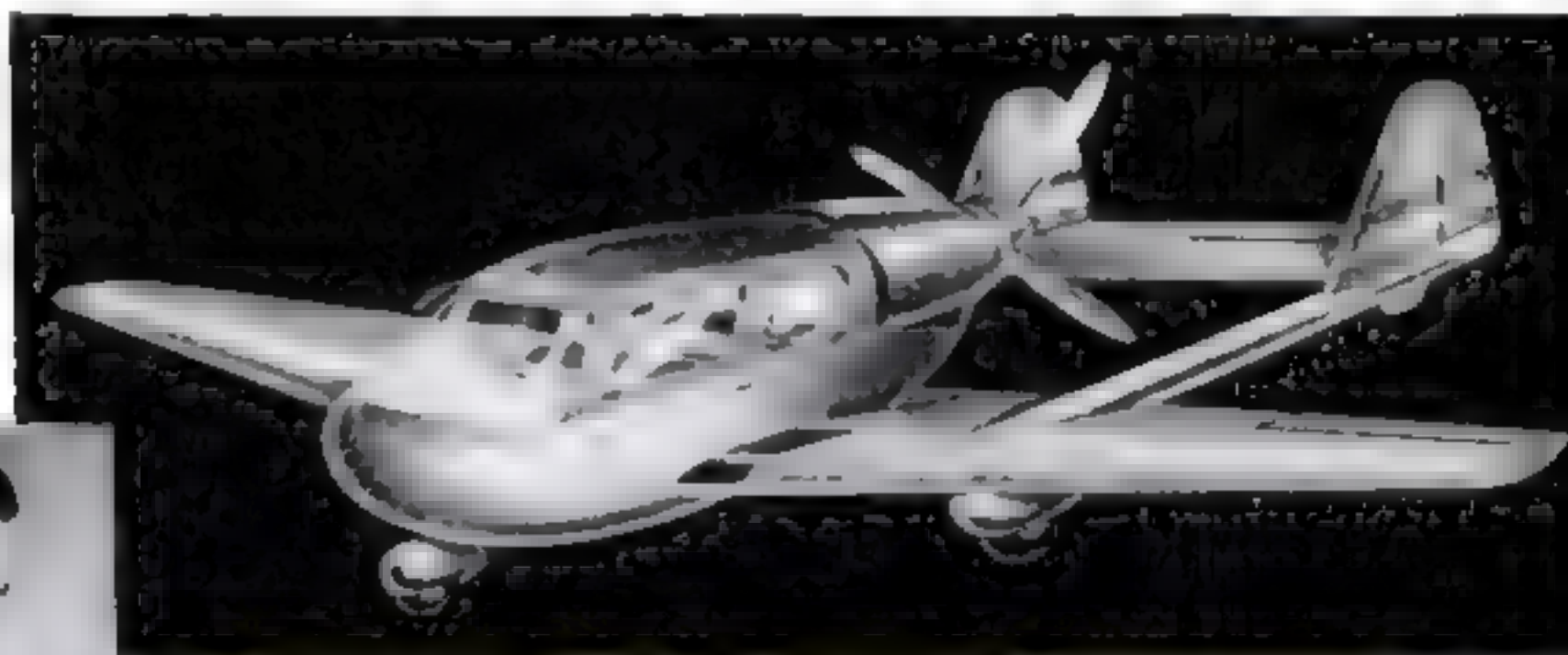




THIS DRAWING IS AS SHE WOULD
APPEAR IN FLIGHT

FIRST-PRIZE: NONPROFESSIONAL

From the far Pacific came this original sketch, to win first prize in the non-professional class. Note the inverted gull wing and the P-61-type tail and rudder. The sun shield above the cabin contains air-conditioning equipment fed by a tube in the rear of the molded window. Right, Private Fotheringham, designer



FIRST PRIZE: PROFESSIONAL

Closely resembling the other top plane, except in using a regular gasoline engine instead of jet propulsion, the first prize winner in the professional class exhibits sleek lines and interesting details. Note spoilers and tail skids. The designer is Donald J. Wheeler, Boeing engineer, of Seattle, Wash., seen at left

PROFESSIONAL CLASS

FIRST PRIZE \$1,000 War Bond, Donald J. Wheeler, Boeing Aircraft Co., Seattle, Wash.

SECOND PRIZE, \$500 War Bond, Robert C. Kelley, Chicago, Ill.

THIRD PRIZE, \$300 in War Bonds, Capt. Adam J. Stolzenberger, Air Corps, Dayton, Ohio.

FOURTH PRIZE, \$200 in War Bonds, George A. Owl, Aerona Aircraft Corp., Middletown, Ohio.

FIFTH PRIZE, \$100 War Bond, Pvt. Richard G. Naugle, AAF, Wright Field, Dayton, Ohio.

SIXTH PRIZE, \$50 War Bond, Pvt. Murrel D. Hobt, AAF Convalescent Hospital, St. Petersburg, Fla.

FOURTEEN PRIZES, \$25 War Bond each: Jack G. Abbott and Leonard A. St. John, Goodyear Aircraft Corp., Litchfield Park, Ariz.; Walter J. Boyce, Dearborn, Mich.; Pulaski Broward Jr., New York, N. Y.; A. C. Coffman, Akron, Ohio; Lt. Gene Douglas Davis, San Marcos Army Air Field, San Marcos, Tex.; Moron T. Hockman, Canal Winchester, Ohio; Emmett Horton, Dearborn, Mich.; Lt. Wm. H. Kuhlman Jr., Laurel, Miss.; Constance Pearson, Los Angeles, Calif. and Arthur V. St. Germain, Wright Field, Dayton, Ohio; J. C. Roby, Montreal, Canada; Paul L. Schell, Miami, Ohio; Keith Slipp, Anderson, Mo.; Stanley D. Whitaker, Los Angeles, Calif.; Daniel E. Zuck, Los Angeles, Calif.

LIST OF WINNERS

NONPROFESSIONAL CLASS

FIRST PRIZE, \$1,000 War Bond, Pfc. Dan L. Fotheringham, U.S.M.C., PPO San Francisco, Calif.

SECOND PRIZE, \$500 War Bond, Homer O. Hacker, Dayton, Ohio

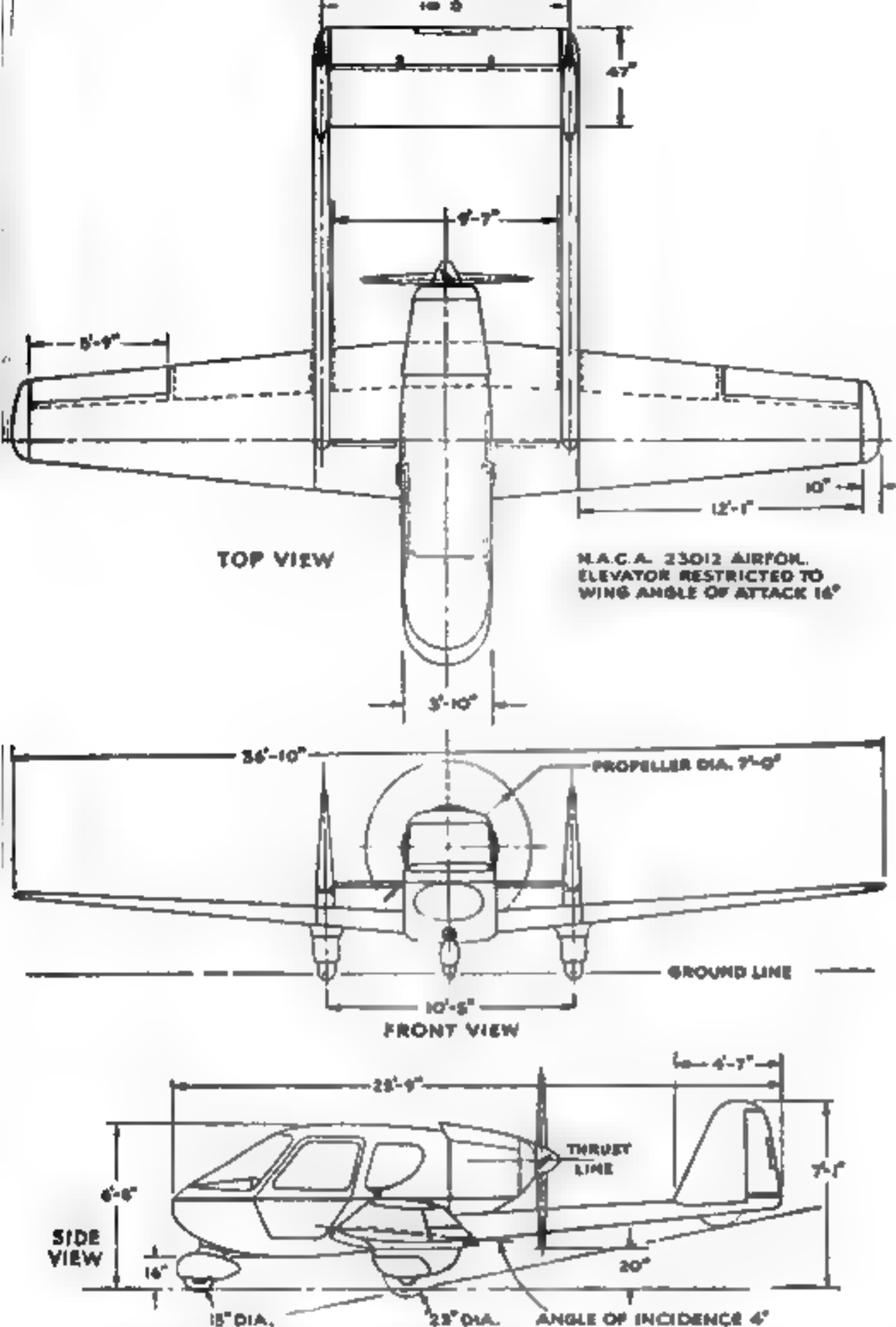
THIRD PRIZE, \$300 in War Bonds, Cpl. Howard A. Wolf, Chicago, Ill.

FOURTH PRIZE, \$200 in War Bonds, Velus Jones, Burbank, Calif.

FIFTH PRIZE, \$100 War Bond, Carl W. Thompson, Jr., New Castle, Del.

SIXTH PRIZE, \$50 War Bond, Ed "Wings" Linthicum, South Kelly Field, Tex.

FOURTEEN PRIZES, \$25 War Bond each: Virginia Armstrong, Clarkburg, W. Va.; A. J. Brault, Belleville, Ill.; M/Sgt. Herman B. Carpenter, Durham Army Air Field, Raleigh, N. C.; William Drake, Malden, Mass.; T-5 Ralph G. Hetta, Fort Bliss, Tex.; Karl L. Griffin, Bethlehem, Pa.; Eugene Lucka, Chicago 35, Ill.; Pfc. George Schreiner, Fort Benning, Ga.; A/C Roy W. Jackson, Blackland Army Air Field, Waco, Tex.; Sydney Nesbitt, New York, N. Y.; Creighton E. Pool, Norfolk, Va.; Sgt. Francis E. Rantz, Scott Field, Ill.; Lt. James W. Sheld, Deming Army Air Field, Deming, N. Mex.; Harold B. Stucky, South Hutchinson, Kan.



DETAILS: PROFESSIONAL-CLASS WINNER

"Model 111," as Wheeler calls his design, would be powered by a 130-hp. Lycoming Model 290-A or similar engine. With wing loading of 15 pounds to the square foot, it would carry a useful load of 1,030 pounds, including four passengers, 160 pounds of baggage, fuel, and oil. Its cruising range would be 475 miles; top speed at sea level, 130 m.p.h.; cruising speed, 115; landing speed, 45. Service ceiling, 13,000 feet. Fuel consumption, 7.35 gallons per hour

whirling blades when the plane is on the ground.

Seats for four passengers to make flying a family affair.

Tricycle landing gear to take care of "sloppy" landings.

A speed of about 130 miles an hour and horsepower running from 110 to 200.

Adequate luggage space.

A range of 500 miles to obviate the need

for frequent landings to refuel.

A price—and here was a surprise—running from \$1,500 to \$3,500 for an airplane with performance, in preference to \$1,000 or under for one with limited speed and range.

Those were the findings by a board of experts who piled the entries on a table, locked the door, doffed their coats, rolled up their sleeves, and worked for days to choose the winning designs. When they were through, they had the first generous public sampling of public opinion on personal-airplane design ever attempted.

There were other surprises. One, for instance, was a relatively low preference for whirling-wing aircraft, such as helicopters.

But the compelling fact was the high degree of talent, coupled with the similarity of the aerodynamically sound aircraft that won top honors, shown by the contestants. Many good designs, just a shade shy of those qualities that would have enabled them to capture one of the two first prizes, were recognized by the judges with awards.

Here are the two Number One winners:

Nonprofessional: Marine Pfc. Don L. Fotheringham, of Idaho Falls and Los Angeles, now in the Western Pacific pasting the Japs.

Professional: Donald J. Wheeler, of Seattle, employed as an engineer by the Boeing Aircraft Com-

pany, builder of the famous Flying Fortresses and Superfortresses.

Private Fotheringham's entry was composed of penciled drawings, supported by an explanatory essay.

Mr. Wheeler's entry was—and here's the engineer's deft touch—a beautifully executed picture supported, also, by drawings and an essay giving the anticipated performance and construction data.

But whereas the professional entry was conventionally propelled by a reciprocating gasoline engine and propeller, the nonprofessional was jet-propelled. Prophecy often is written on a piece of foolscap.

Each design was considered first as to practicability, then as to safety, originality, and general merit. The final test of the designs, as set forth in the rules of the contest, was that they "would find the greatest postwar market among the thousands of prospective pilot owners." Of particular interest, naturally, are the first-prize winners in the two classes.

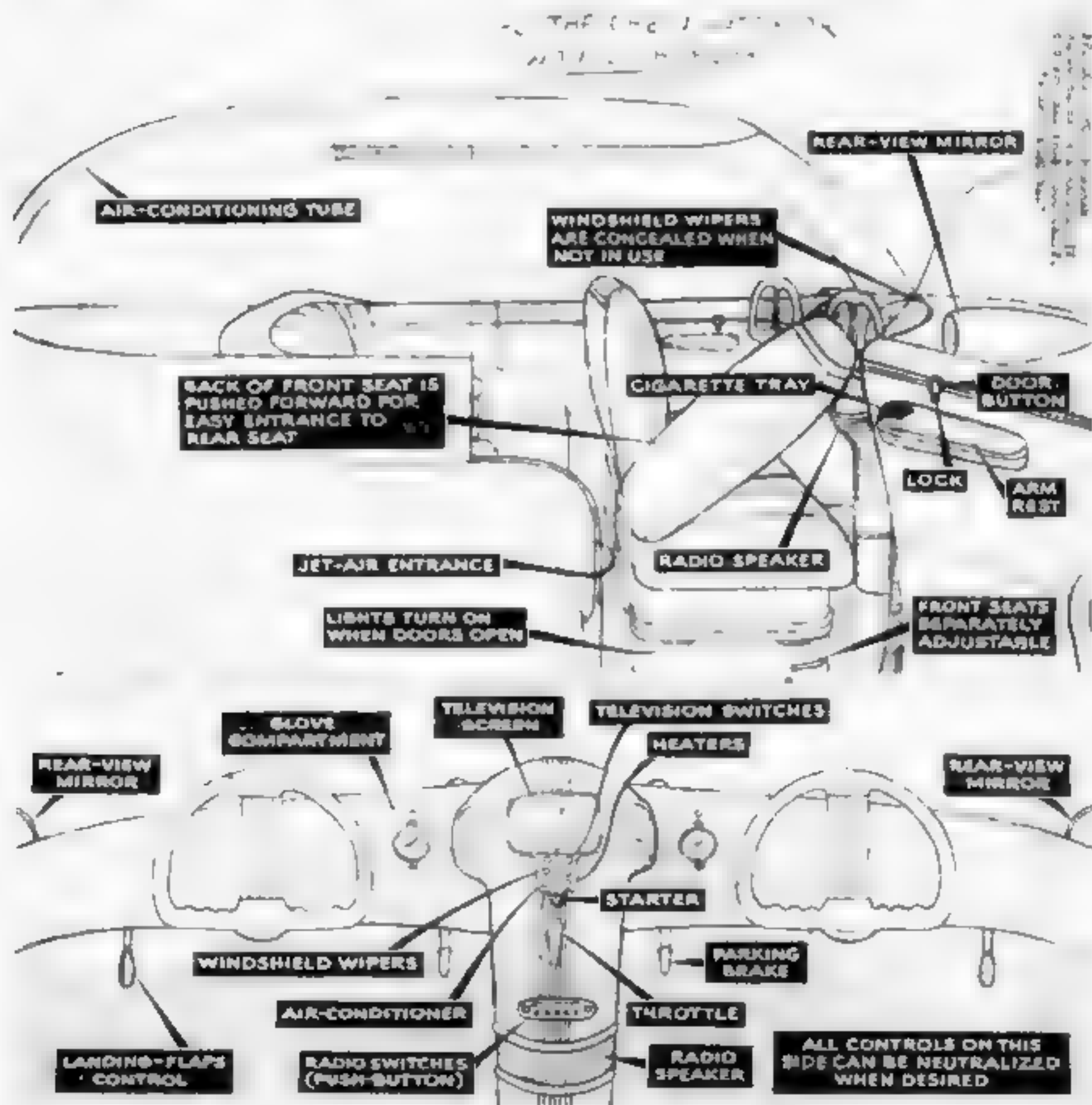
The entry of Mr. Wheeler is shown on page 85 in his own rendering. It is a four-place, twin-tail-boom model with a pusher propeller mounted between the tail booms, which form a "fence" around the dangerous blades.

This "Model 111," as Mr. Wheeler designates his entry, is a non-spinning, non-stallable design, to quote his descriptive material, and includes many of the features demanded by the majority of the entrants. The landing gear is fixed, rather than retracting, but is nicely streamlined. Of this Mr. Wheeler says: "This designer doesn't

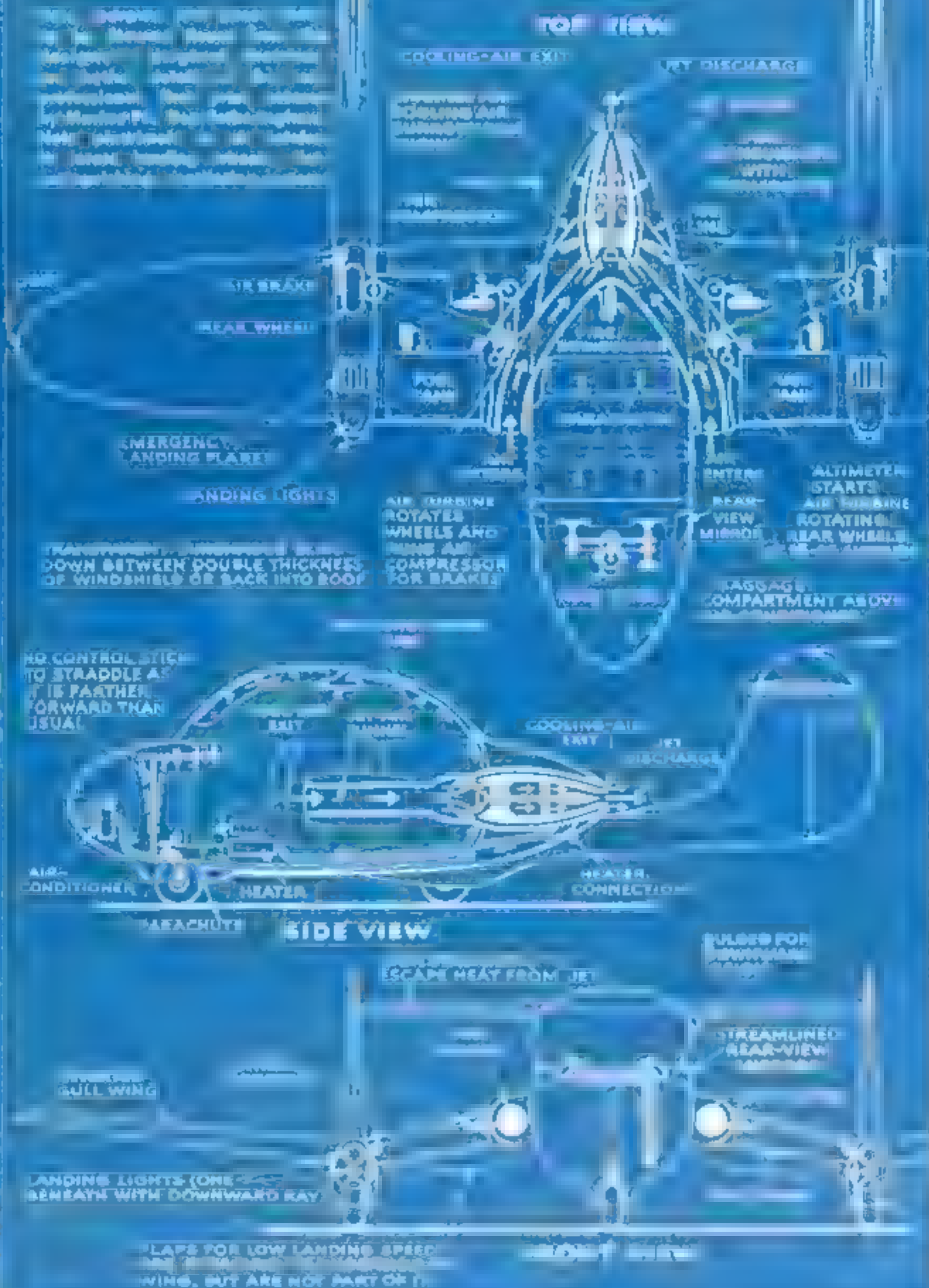
INTERIORS: NONPROFESSIONAL-CLASS WINNER

Here are the original interior sketches for the Fotheringham design. Excellent visibility provided by the seating arrangement is furthered by an outward bulge that gives a view downward without bank-

ing. The lower sketch shows the instrument panel, with built-in push-button radio and a television screen. A better arrangement of instruments might be suggested, but the general effect is pleasing



DETAILS: NONPROFESSIONAL CLASS WINNER



want to give them (average pilot owners) the chance to forget to put the gear down."

The nose wheel is fully steerable for better ground handling, and hydraulic brakes add to the safety. For rough fields there are tail skids incorporated in the booms to protect them and the rudders. The wing is the NACA 23012 airfoil section with a split trailing-edge flap for slow landings.

With the engine in the rear, any objections to noise, poor visibility, and engine fumes are done away with. The interior of the plane is comparable to that of the modern automobile in roominess, styling, and comfort items. A complete set of instruments is included, and all knobs and handles are flush with the instrument board for safety.

The cost of gasoline and oil at 75 percent of power is estimated at \$1.837 per hour.

Small spoilers are located on top of the wing between the cabin and the boom ends to allow rapid descent without diving or slipping the ship.

In the nonprofessional class, some of the entries were more interesting and attractive than they were practical from an aerodynamical standpoint. Nevertheless, much of the talent shown by the top few hundred was on a par with many of the professional entries.

The winner in this class, who listed his occupation as "knocking hell out of the Japs so that I may return home to the following type of plane," and his position as "a private, first class, in the world's finest military organization," really startled the judges with his entry. It had everything!

Marine Pfc. Fotheringham whose entry is reproduced on page 85, worked out his ideas on tissue paper while off duty. This fighting leatherneck, who left school to work in a defense plant and then enlist in the Marines, has seen service on Roi, Namur, Saipan, Tinian, and the Carolines. When on June 3 a copy of the June POPULAR SCIENCE MONTHLY reached him and he spotted the "Plane You'd Like to Own" contest, he wrote his mother in Los Angeles that the

deal was "too good to pass up," and that he was going to spend all of his spare time on it.

Later he wrote: "Maybe you think it's silly, but I've been plugging away on my design. It's to be a jet-propulsion plane. I've worked hard on my design and hope to do well with it. Maybe not win, but perhaps they'll mention my name." Don's time was well spent.

In going over his detailed plans shown on pages 87 and 88 the judges noted such clever items as a fire-extinguisher unit mounted at the junction of the two air intakes for the jet engine so that at a touch of a button (or automatically) the entire jet engine is flooded with extinguishing liquid. The doors lock from either side. Air-conditioning tubes and intakes from the jet either warm or cool the passenger compartment. The nose wheel is steerable, and the dual controls may be removed if desired for a single-pilot trip. All standard flight instruments are included.

The judges unanimously felt that this entry richly deserved top honors in the non-professional class because it showed great thought, attention to detail, and foresight.

The comments of the judges on the entries as a whole should be very gratifying to all the contestants. Oliver L. Parks said, "This contest has advanced the thinking and engineering development at least a year in private-plane manufacture." This feeling was echoed by Roger Schlemmer, who believes that "many of the ideas presented will become an actuality in the not-too-distant future" and that the contest response is "another demonstration of America's leadership in postwar aircraft design."

Col. Earle Johnson remarked that "it (the contest) has shown the way to many advanced ideas which will come into practical use in the very near future," and that "it has given a national outlet for constructive ideas which will promote aviation and thus allow us to maintain the supremacy of the air which we now enjoy."

In Forthcoming Issues: **The Plane You'll Own**

WHAT it will look like, what equipment it will have, will be revealed by our analysis of 3,345 contest entries showing important design trends. See the plane you'll own, in color—a composite design embodying the many preferences revealed by contestants. Other prize-winning designs, many in full color.





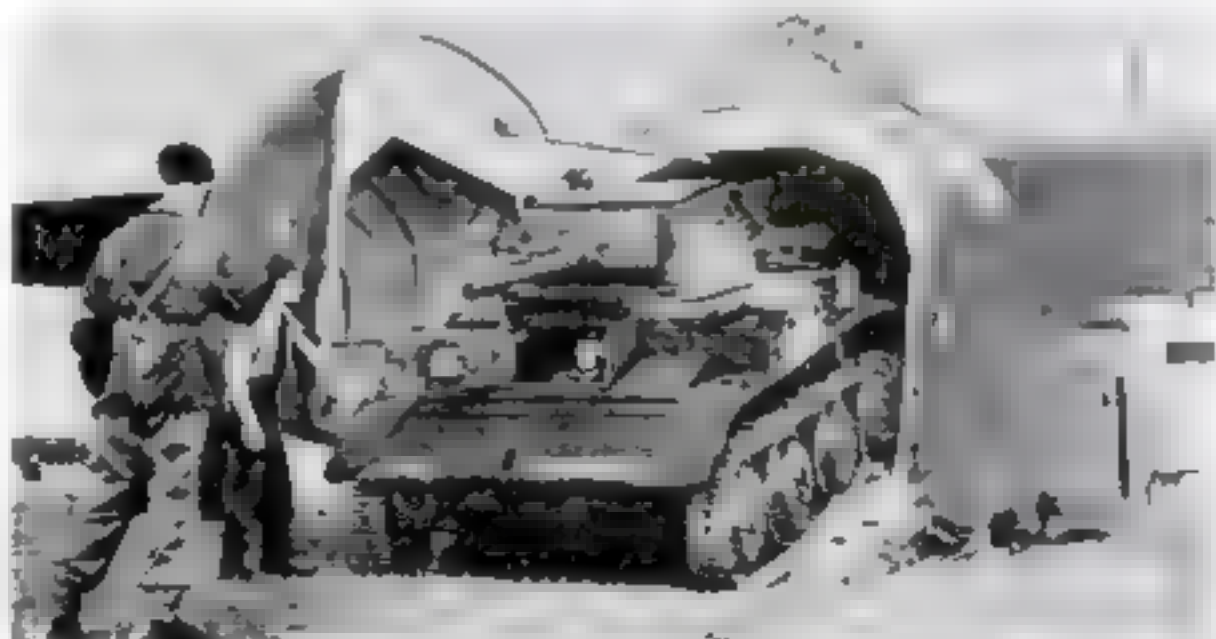
FOR CATCHING UP WITH ROBOTS this newest fighter plane of the RAF, the Hawker Tempest, has proved itself by enabling its flyers to knock out fully 600 flying bombs since it was introduced. Its extra speed and maneuverability have also made it effective in operations against the Nazi jet plane,

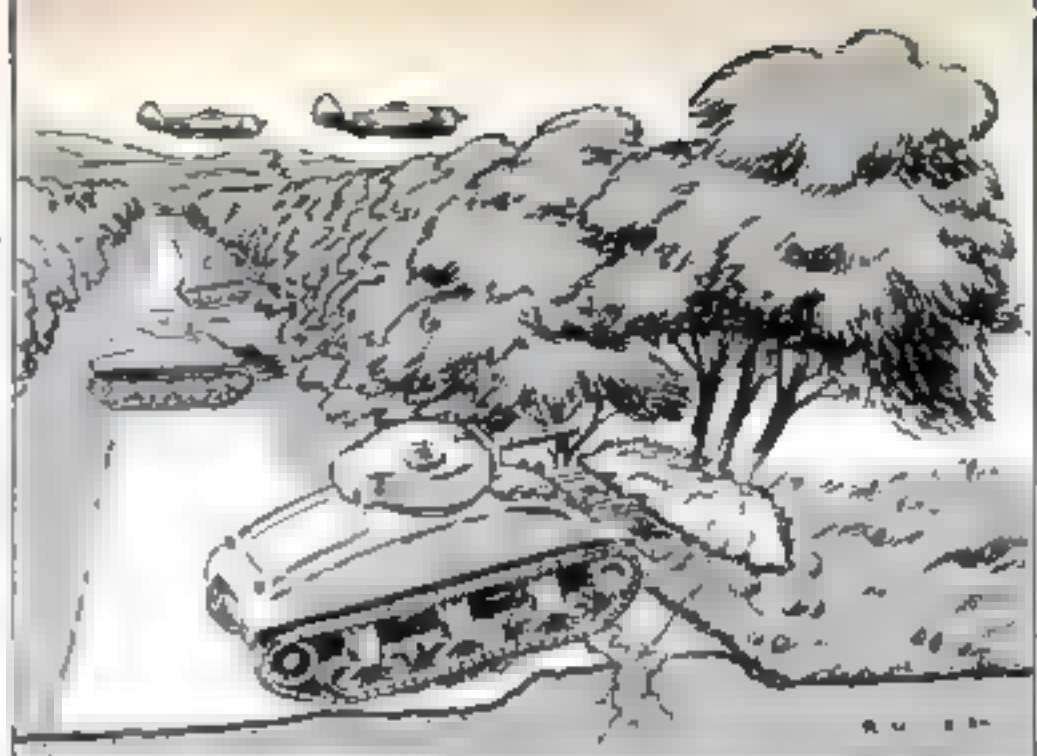
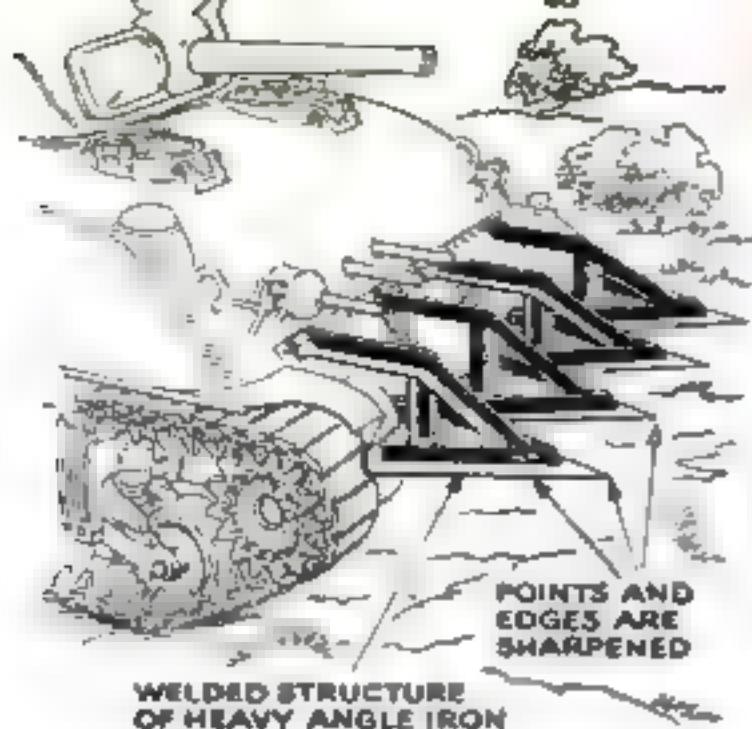
Messerschmitt 262. The Hawker Tempest has a wing span of 41 feet, is 33 feet 8 inches long, and carries four 20-mm. cannon. Power is supplied by a supercharged 2,200-hp. engine, driving a four-bladed propeller. The Tempest joins the famous Hurricane and Typhoon in the Hawker "storm" series.



BRITISH OIL. An oil field in Britain is now producing oil at the rate of 100,000 tons, or 26,000,000 gallons, a year. For obvious reasons the location must not be divulged at present. The field is small, but the oil is of the highest quality, ranking with the very best in the world. As might be expected, it yields the whole range of refinery petroleum products. The photograph shown at the left pictures a pumping jack as it begins its job of getting out the oil. Production, which was nothing before war, was built up rapidly to provide a supply of oil that no submarine could sink.

FITS LIKE A GLOVE. The British Hamilcar glider was specially designed to accommodate with no waste space the swift, hard-hitting, seven-ton Tetrarch light tank shown here backing into the nose of the craft. The combination is used by airborne invasion armies, and has already seen effective service in the landing of Allied forces behind the enemy's lines.





FOUR-PRONGED TANK FLOW devised by Sgt. Curtis G. Culin, of Cranford, N. J., contributed to the vital American breakthrough at St. Lô. Normandy hedgerows, planted on three to five-foot embankments,

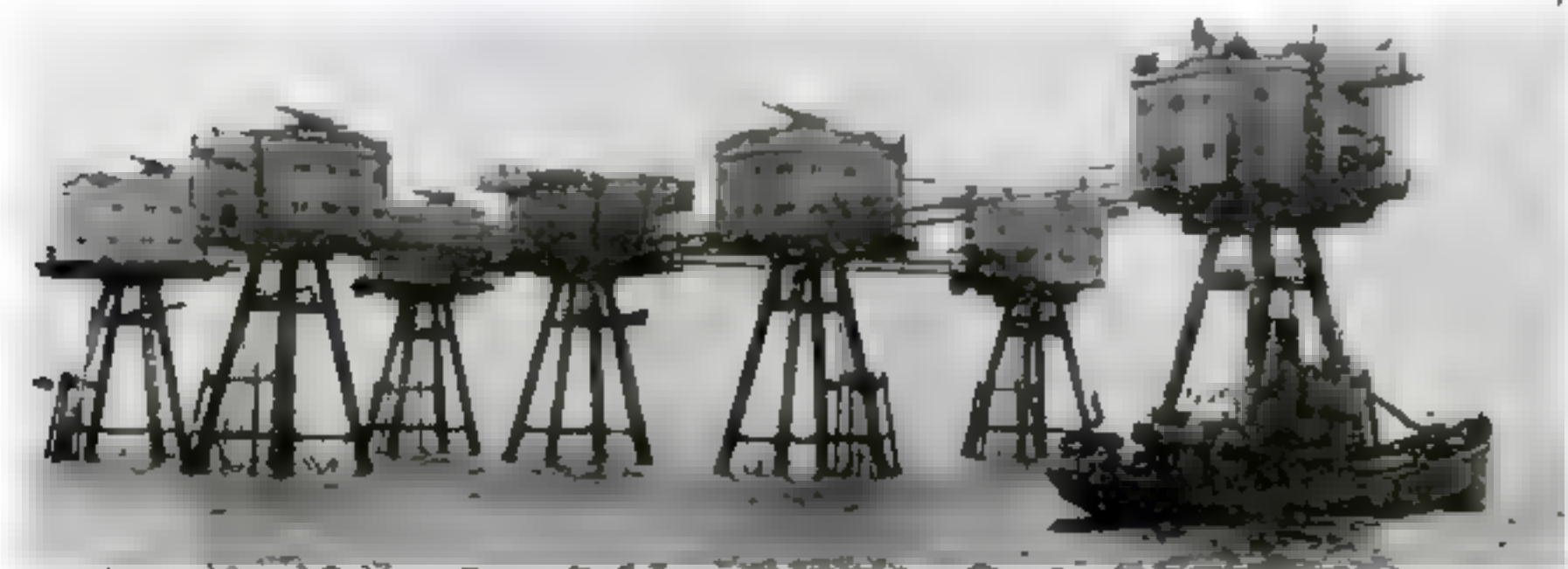
hampered our tanks until Culin suggested providing them with sharpened prongs made of the heavy angle iron left as tank barriers by the Germans. In 48 hours, 500 tanks so equipped plunged ahead.

IT'S A PILLBOX, although it looks like something else. The Smiths' book-stall in Parliament Square, London, with its realistic dummies, was one of many camouflage fronts built in 1940 for the British capital's strategic points when invasion seemed imminent. Another pillbox disguised as an information bureau was built on the site of King Charles' statue in Trafalgar Square, and protected approaches to Whitehall, Buckingham Palace, and the Strand.



"BATTLESHIPS ON STILTS" guarding Britain's shipping lanes are shown (below) by first available photograph. These tower forts, which are manned by army personnel, were constructed on the mainland and

towed out to their location at sea where they were positioned on a sandbank, armed, and connected with catwalks. The job of these deep-sea forts was to defend Allied ships against enemy mines and mine-laying planes.

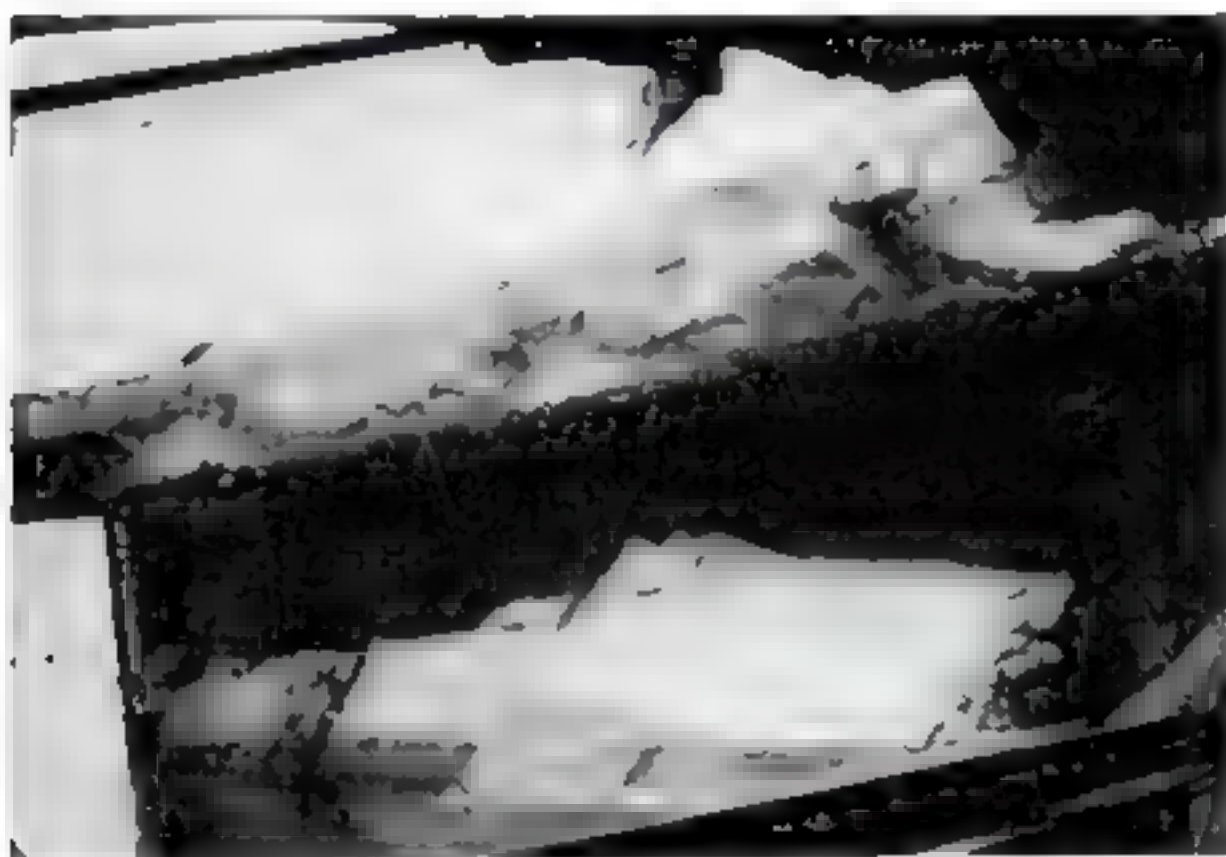




SIX-TON COOKIE, the blunt-nosed blockbuster forerunner of the new British earthquake bomb



EARTHQUAKE BOMBS RARIN' TO GO. RAF armorers service them for raids on toughest enemy strongholds. They penetrate even thick concrete before they explode with devastating effect



A BOMB WENT TO TOWN on this reinforced concrete pen for enemy patrol boats. Blast wrecked the shelter Germans thought safe

IMPROVED EXPLOSIVE RIVET, recently announced by Du Pont, speeds work on military planes and increases uniformity. By adding a small auxiliary cavity in the shank of the rivet and modifying the explosive charge, practically the entire shank is expanded by the detonation. A tight fit is thus assured without the necessity of drilling holes to micrometer accuracy. The rivets make possible from two to five times the former speed.



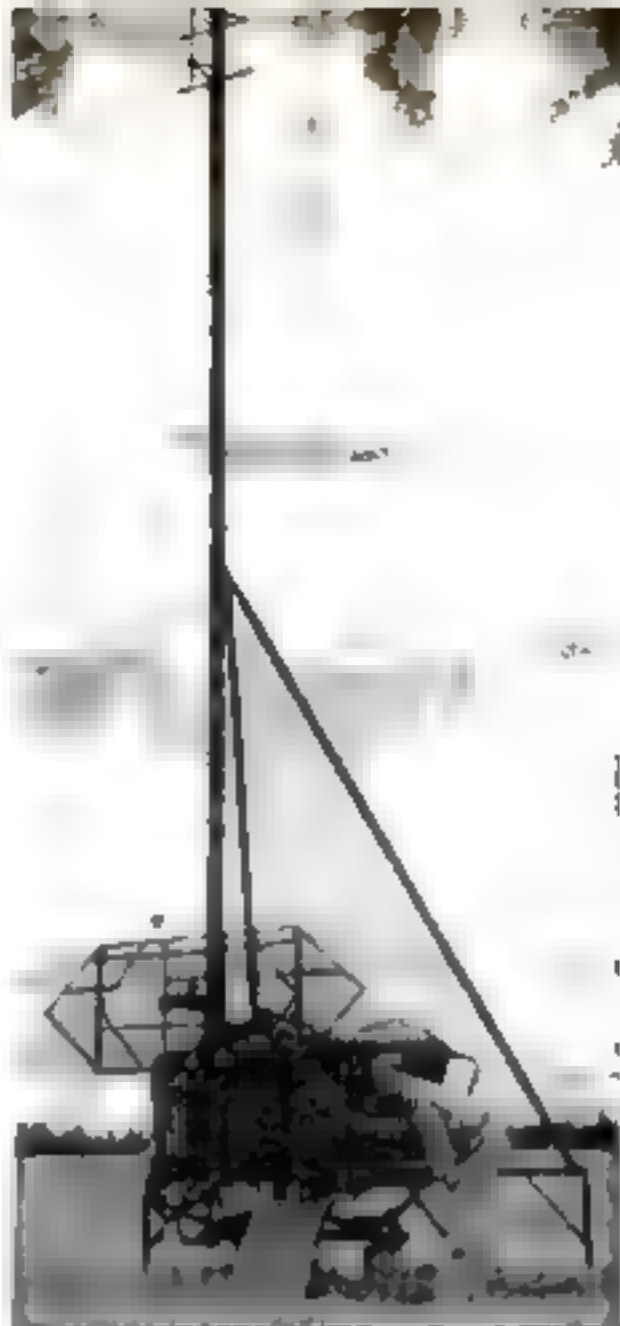
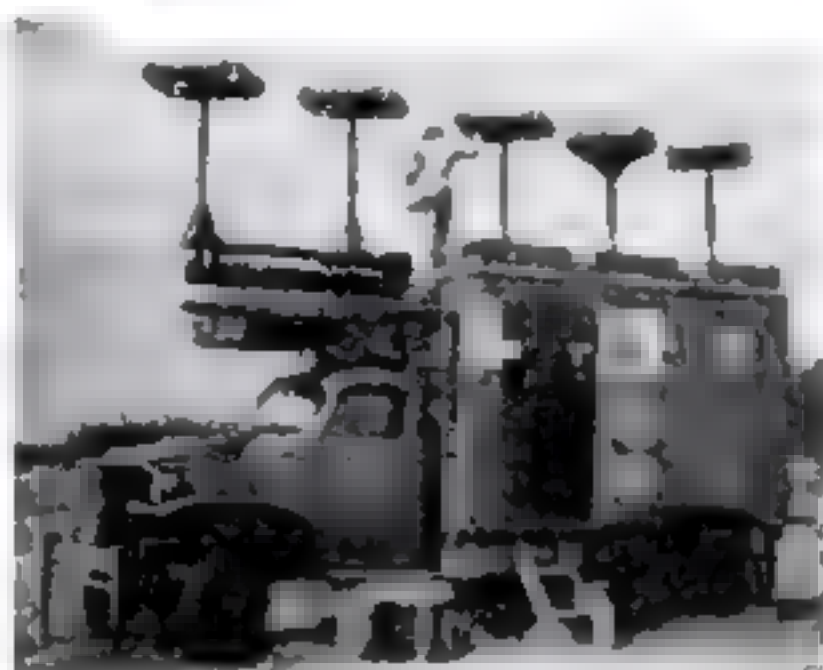
TRIFOCAL eyeglass lenses make it easy for older Army pilots to use overhead dials and switches as well as to read maps and work with panel controls. With ordinary bifocals, the *Air Surgeon's Bulletin* reports, men with lowered power of accommodation found it difficult to see the overhead instruments.

Army Lands Planes by Radio

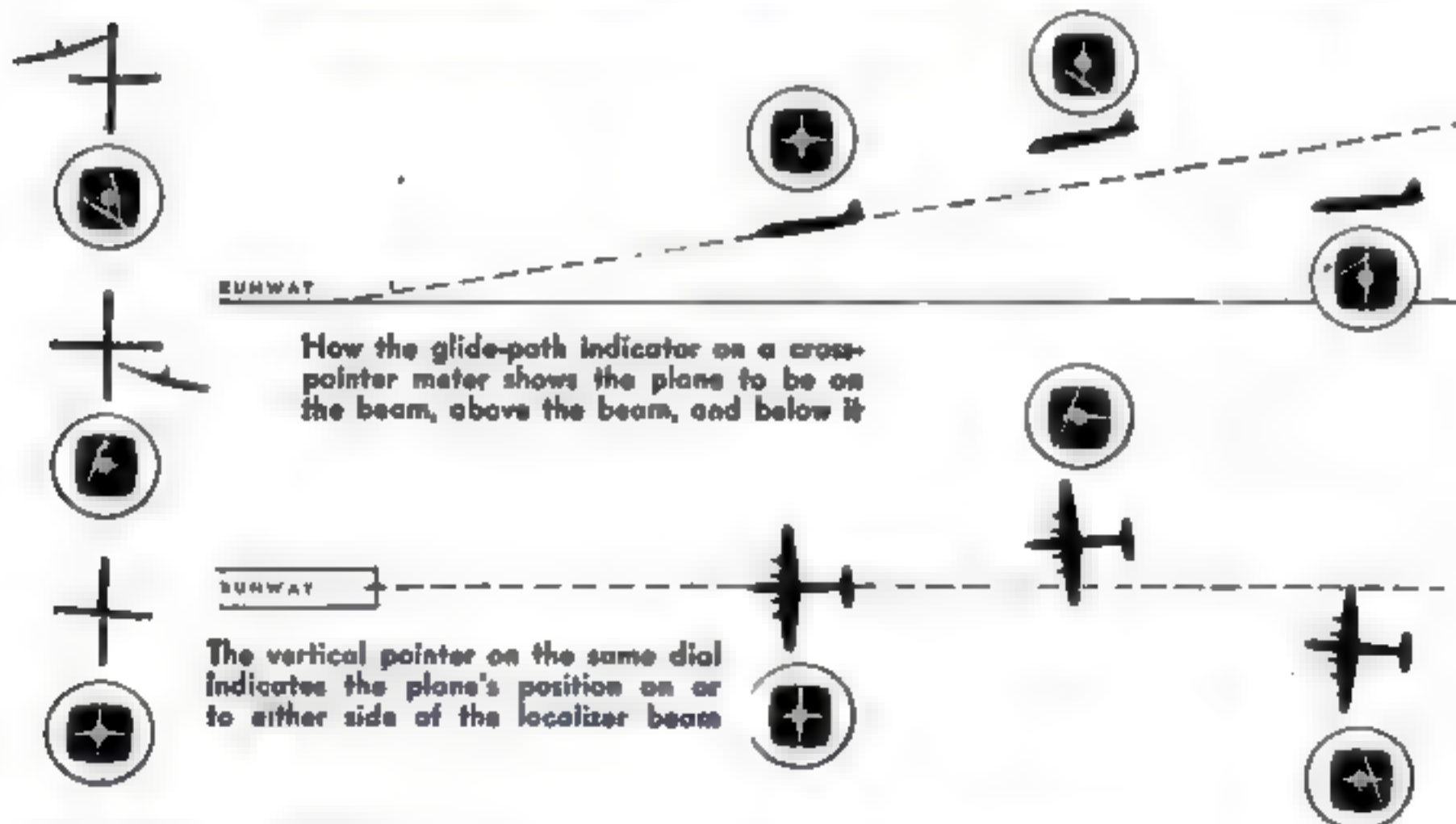
ARMV pilots are guided to safe landing on overcast fields by the AAF's new instrument-approach system, which embodies refinements on previous military and commercial blind-landing equipment.

As described by Lt. Col. F. L. Moseley in *Air Force, Official Service Journal* of the USAAF, the Army system employs a directional localizer beam and a slanting path transmitted by mobile equipment on the field. Approaching on the radio range, a pilot switches his radio navigation equipment to the local channel about 20 miles from the field. Flying along the localizer beam at 2,500 feet altitude, he intersects the glide path about 13 miles out and follows it down to the runway. His position with reference to the localizer beam and glide path is shown by a cross-pointer meter on the instrument panel. Operating at ultrahigh frequencies, the system is immune to ordinary static.

Mounted on a truck, the localizer transmitter is placed about 1,000 feet from the upwind end of the runway. It can be moved quickly if a change in the wind makes it necessary to bring planes in to the field from a different direction.



Glide-path signals are transmitted by this portable equipment, which is placed about 750 feet upwind from the approach end of the runway and some 400 feet to one side.



Pilots approaching the runway are able to determine their positions from the horizontal and vertical lines on the dial. The dot represents the position of plane; intersection of the pointers, the flight path



Centered on the runway by a beam from the localizer transmitter and guided down through the overcast by a glide-path indicator, a pilot is able to come in for a safe landing



AIRBORNE LIFEBOATS are used by the RAF as well as by the American B-17 (P.S.M., Nov. '44, p. 137) in air-sea rescue work. They are dropped by parachute, fully equipped with sails, two motors, and rocket life lines that operate when the boats alight on the sea. Built of wood, they have two buoyancy chambers, and, as in the American boats, the length is 27 feet. They are carried by Warwick aircraft, used for transport work.

PLASTIC BINOCULAR for the armed forces has been designed and developed by the U.S. Naval Observatory. Plastic parts fabricated by the General Electric plastics divisions at Pittsfield, Mass., show extreme resistance to fungus growth and corrosive effects of salt water and air.



WICKED WEAPONS of northern Burma are the Kachin dah and Gurkha kukri. The dah, shown in the American officer's right hand, is used by the Mongoloid Kachins as a combined ax, knife, and chisel, and has been strongly recommended for American jungle warfare. The kukri is used by the warlike Gurkhas for similar purposes.

SPECTATORS who occupy the front rows at hockey games stand less chance of being socked in the eye with a flying puck when tough Herculite plate-glass screens are installed at the top of the bounding boards. Drastic tests of the glass have included the driving of scores of pucks against a Herculite backstop without causing any damage to it. The sections used at the rink vary in length, but they are 22 inches high and five eighths of an inch thick. Herculite, a plate glass specially tempered for strength, is manufactured by the Pittsburgh Plate Glass Co., Pittsburgh, Pa.





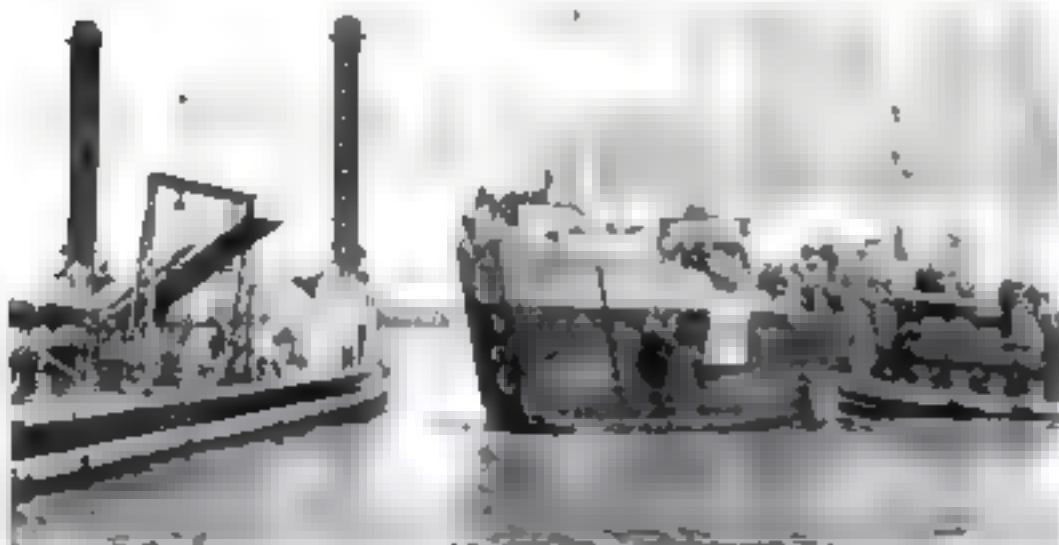
PIERHEADS, consisting of pontoons cutting across steel roadways leading to shore, serve as unloading platforms where the ships can come up alongside and discharge their cargo into waiting trucks. Steel roadways are supported by floats, and are flexible enough to take the rise and fall of a heaving sea.

STEEL "BEACHES" that slope off into the water from the pierheads enable the LST's to "nose up on shore" so they can unload through their bow doors. Beach, below, is shown being put into place at left.

Prefabricated Harbors Made Invasion Possible

TOP marine engineering job of the war has been the installing of two prefabricated harbors on the Normandy coast, one for the Yank sector, the other for the British. The American harbor shown here was later destroyed by a storm. But the British port, the size of Dover, continued in full operation.

Official U. S. Navy photographs



TUGBOATS, both Yank and British, huffed and puffed the prefabricated harbors to speedy completion. Some 85 of these boats made over 210 tows in hauling the necessary equipment across the Channel. Here one of the tugs nudges an LST into a position for unloading.

BRIDGEWAYS are also used by trucks to hustle equipment ashore. Both harbors were built in Britain and designed to handle a minimum of 12,000 tons of stores and 2,500 vehicles a day during first 90 days of invasion.



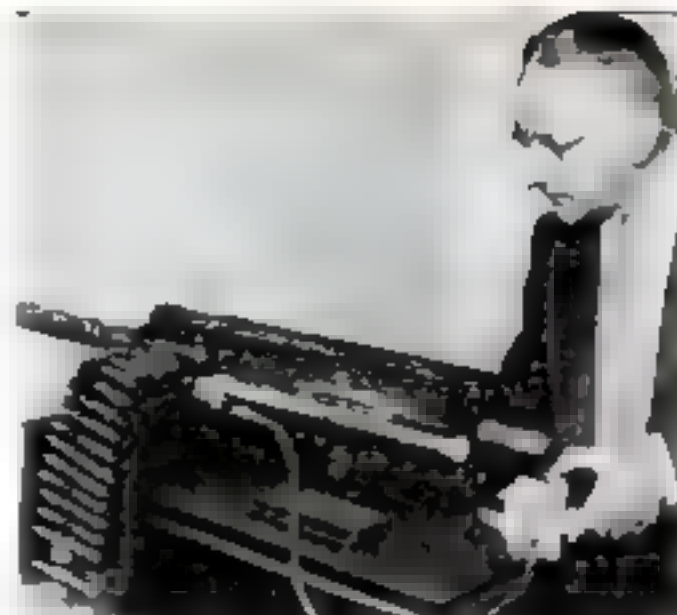
BREAKWATERS to protect the harbors' piers were made up of concrete caissons (above), steel floats, and old ships (below). Some of the caissons were towed 10 miles before being sunk into position. Most of them carried Bofors guns for protection against air attack.

SIXTY SHIPS, some of them obsolete fighters, war steamers into line and then scuttled to form 24,000 feet of breakwater. With characteristic speed, this part of the invasion operation was completed in just five days.





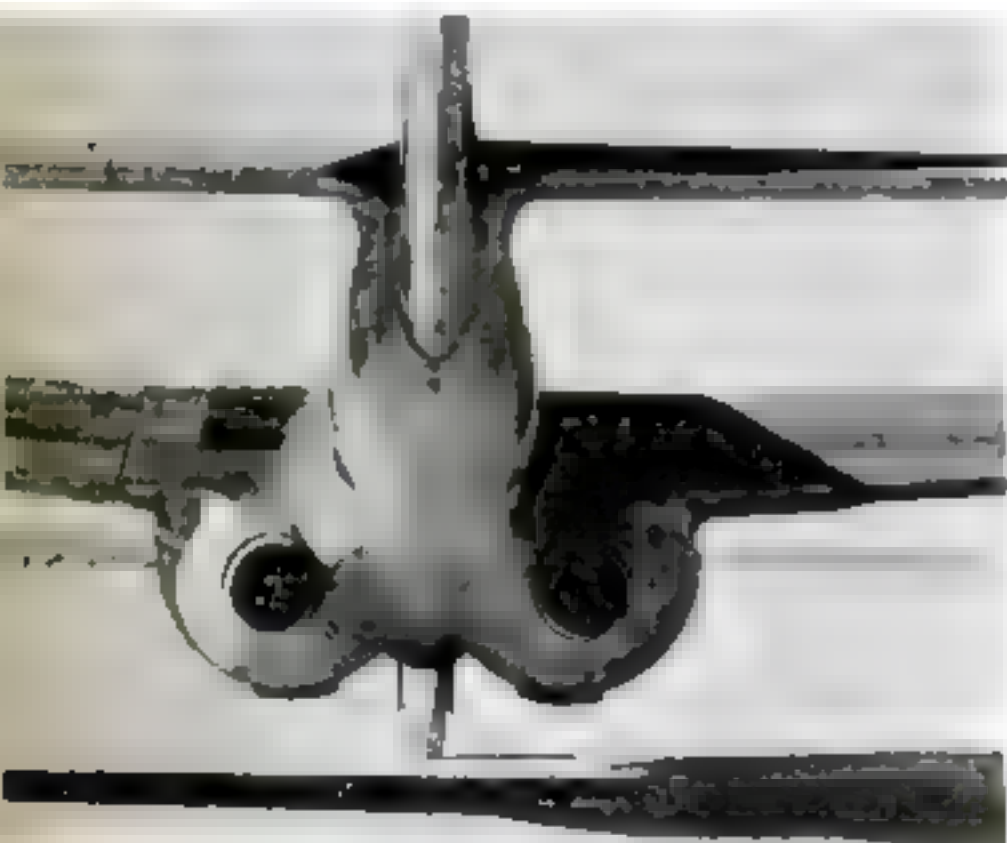
JAMMED GUNS are cleared in a second by a two-pound "gun charger" developed by Walter Kidde & Co. in cooperation with the AAF. At the touch of a button the device goes into action, using compressed air or gas to restore the gun to action, saving precious seconds in combat. It is seen at right under test in the Kidde laboratories.



"SKY HOOK." Based on nature's design for a maple seed, a rotary-wing container devised by the AAF whirls to earth from a plane, carrying up to 65 pounds of supplies for men on the ground. More accurate than a parachute, it may be used after the war for dropping mail.

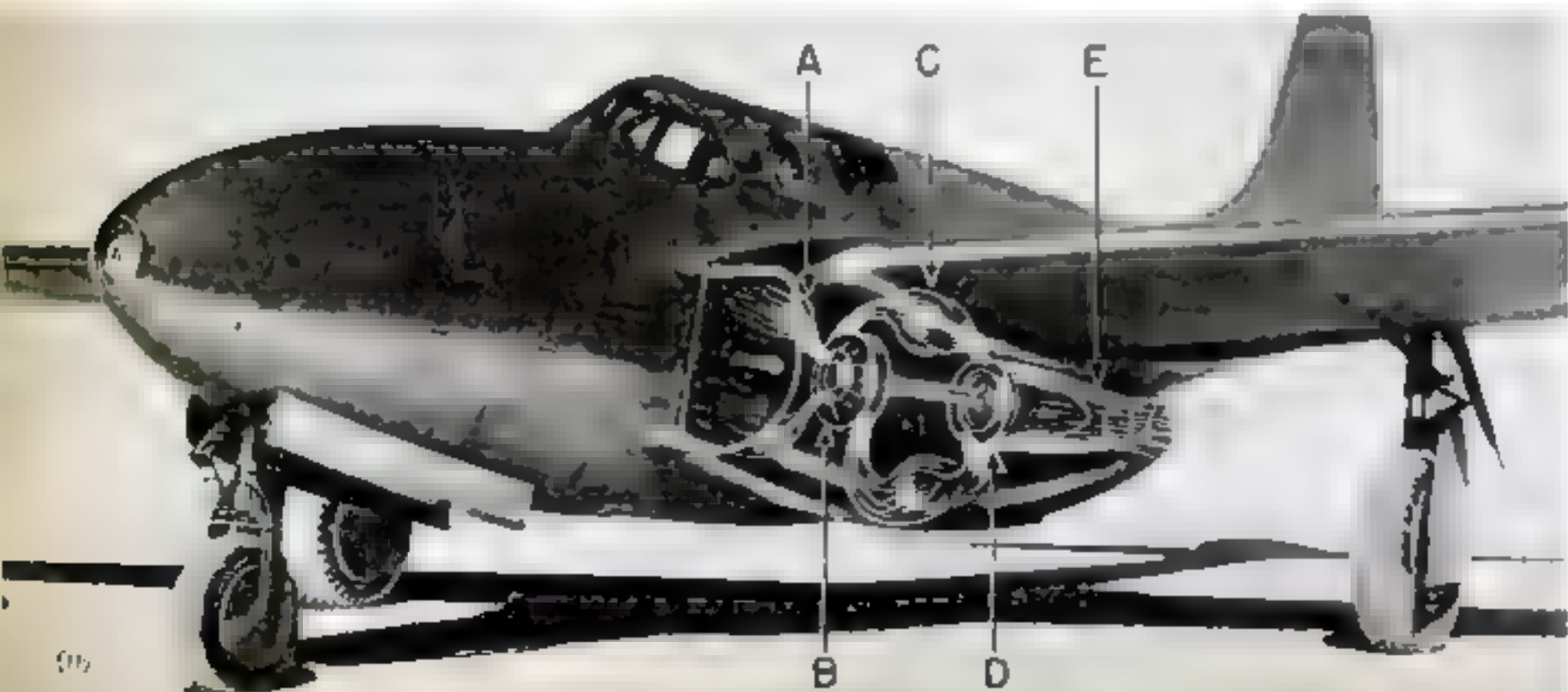


LIGHT and compact, a new Ranger aircraft engine developed by the Fairchild Engine and Airplane Corp. weighs only 870 pounds and develops 700 horsepower for take-off—nearly one horsepower per cubic inch of displacement. It has 12 cylinders.

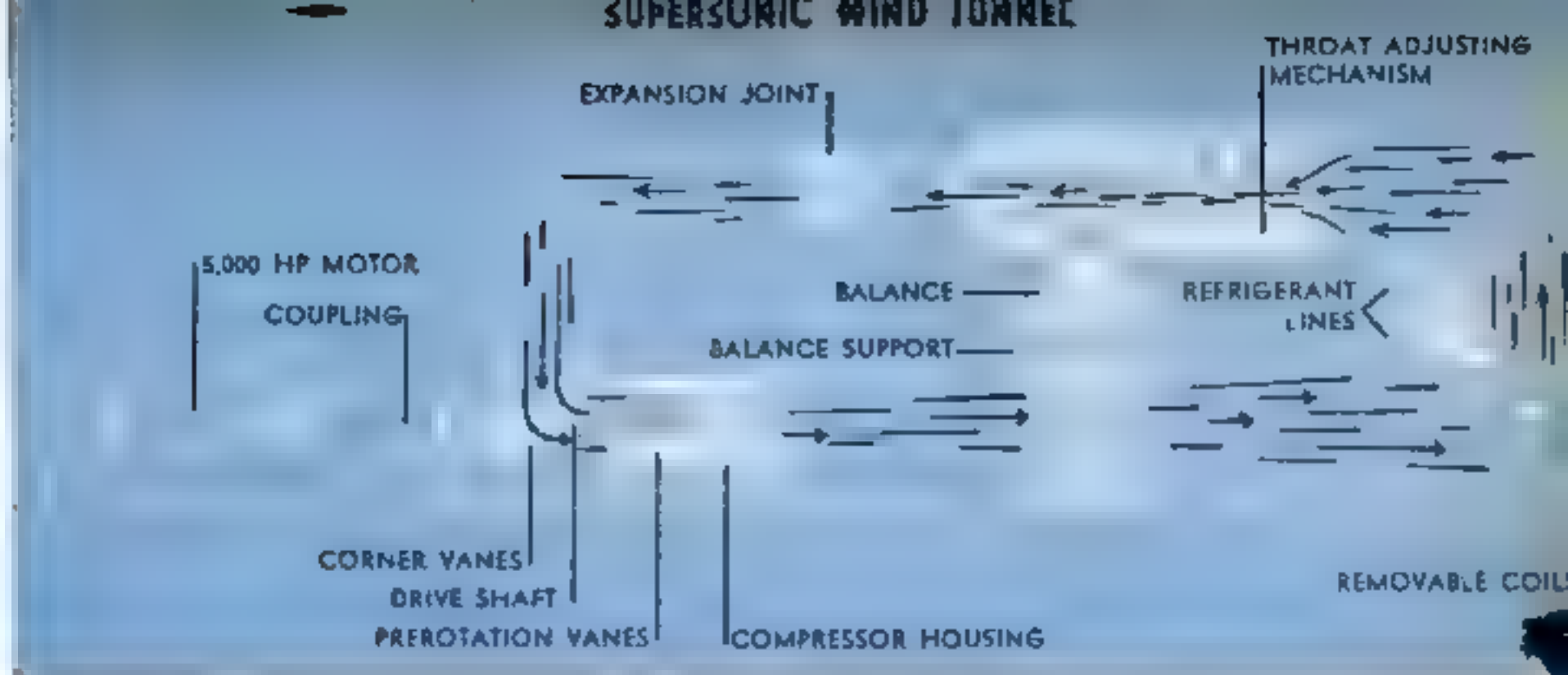


JET-PLANE SECRETS. (New details of the application of jet propulsion in the U S Army's fast P-59A Bell Airacomet fighter have been made public by General Electric, manufacturers of the Turbo Jet engines that drive the propellerless plane at lightning-swift speed in the stratosphere.)

The photograph at the left shows how two of these jet engines nestle snugly beneath the wings and against the fuselage of the Airacomet. (Operation of the novel power plants is illustrated below. Air flows into the intake (A) and is compressed by the blower (B). In the blast chamber (C), it mingles with burning fuel, which raises the temperature. Forced rearward by expansion, it turns the turbine (D) that drives the blower, and escapes through a nozzle (E) at high velocity. The resulting thrust drives the plane forward.



SUPERSONIC WIND TUNNEL



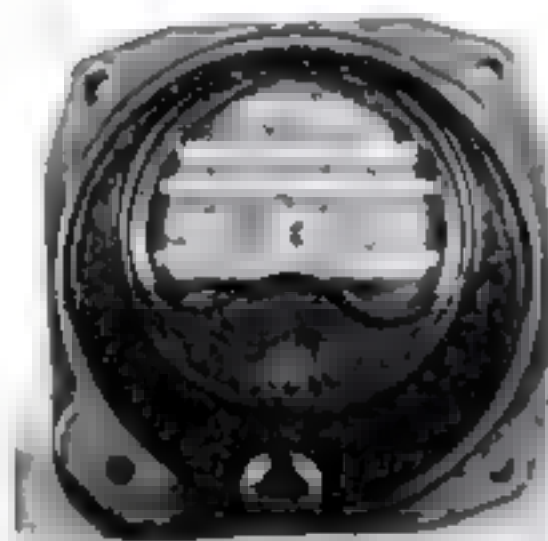
Courtesy of Air Force, Official Service Journal of the USAAF.

TWICE THE SPEED OF SOUND will be surpassed by the stepped-up hurricane created in the new supersonic wind tunnel now under construction at Wright Field, Dayton, Ohio, for testing airfoil sections and small airplane models. This wind, expected to reach a maximum speed corresponding to 2,000 m.p.h. at sea-level conditions, will be blown through a tunnel only one fourth as long as the 20-foot, 450-mile-an-hour tunnel that is now the AAF's largest.

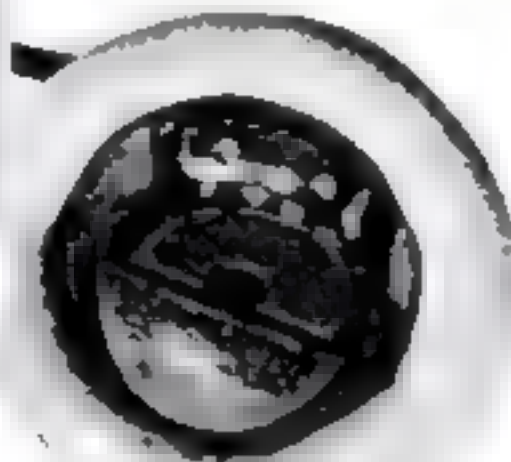
A 5,000-hp. motor drives the compressor

unit to create an airflow of 1,825 m.p.h. at its top speed. When the air is about to enter the test section of the tunnel, its speed is increased by reducing the size of the aperture of the nozzle throat, which constricts the air but allows it to expand and rush smoothly through the chamber with jetlike velocity.

The tunnel is fitted with devices for measuring and recording lift, drag, side force, and other behavior of the airfoil or model being tested.



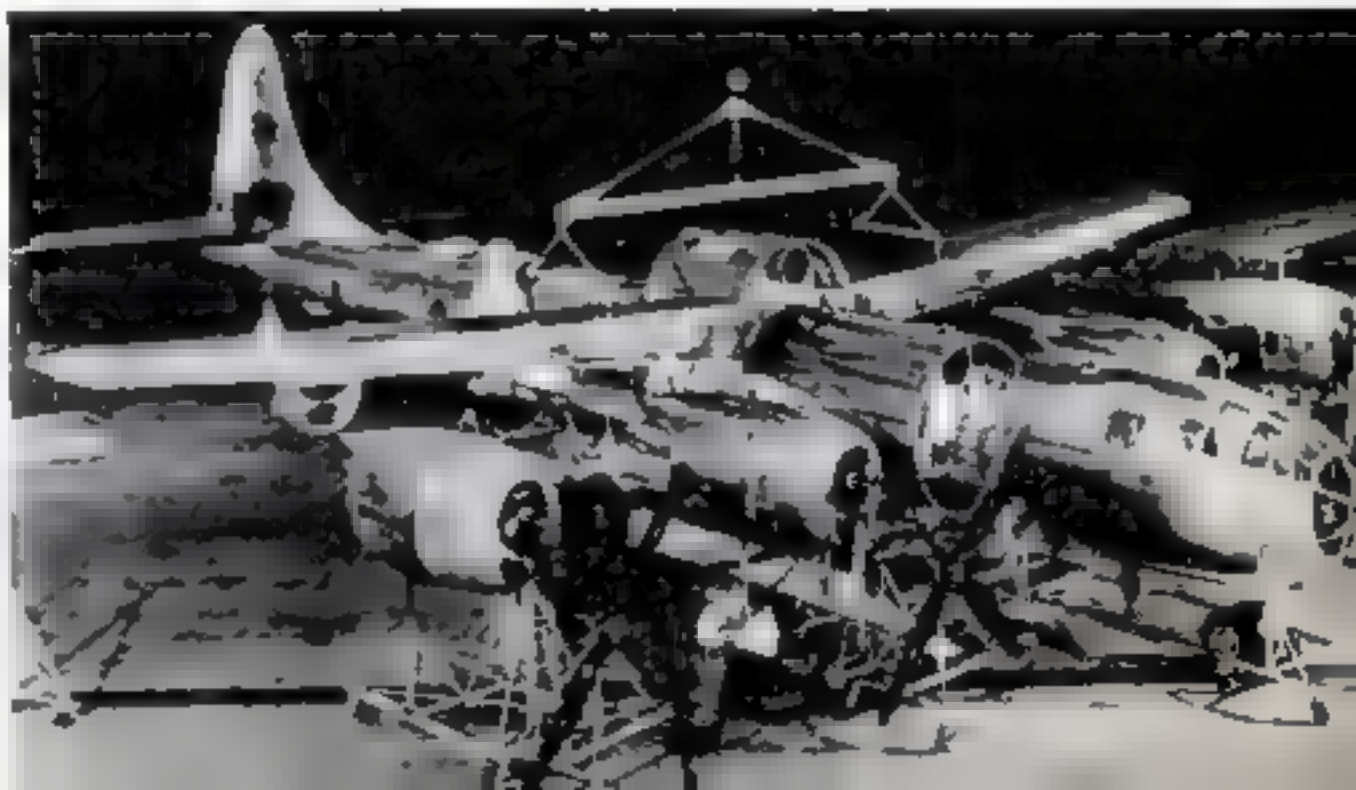
High-altitude flyers check oxygen need by this indicator connected with photoelectric earpiece signaling color of blood. Photos from Air Force.



WARNING OF ANOXIA, or lack of oxygen, is signaled to flyers at high altitudes by an instrument recently perfected in co-ordination with the Air Technical Service Command at Wright Field. The oximeter-colorimeter, as it is called, is built into the flying helmet to fit over one

ear, and is connected by wire to an indicator on the instrument board. Operation is based on the fact that the color of blood changes from the natural bright red to dark purple as its oxygen content decreases. The instrument records this change through the thin ear tissue by means of a photoelectric cell, and warns the flyer when more oxygen is needed.

BREAKDOWN of the Boeing Superfortress design into major units enabled production experts to adapt the multiline assembly system to the giant bomber and thereby beat the delivery schedules set up by the AAF. This photograph, staged to illustrate assembly, shows how sub-assemblies are joined.



P-63 BELL KINGCOBRA FIGHTER

IT'S A BIGGER AND DEADLIER AIRACOBRA,
WITH MORE SPEED AND A HIGHER CEILING



P-39 AIRACOBRA



P-63

VS.

P-39

38 ft.

SPAN

34 ft.

32 ft. 8 in.

LENGTH

30 ft.

1,500-hp.
Allison

POWER

1,150-hp.
Allison

Four-blade

PROPELLER

Three-blade

One 37-mm.,
four .50 cal.

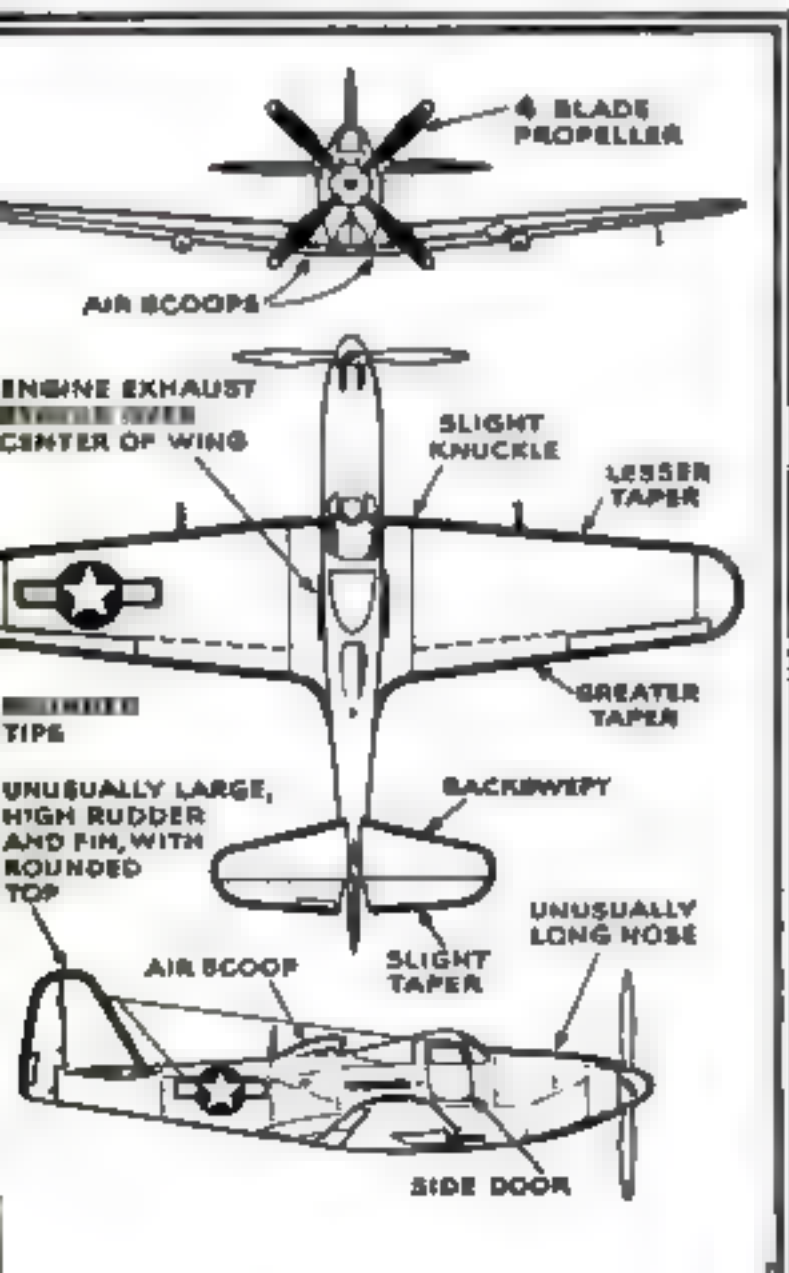
ARMAMENT Same

P-63 KINGCOBRA



IT HAS everything the famous Airacobra had—and more of it. That's the best way to describe the new Bell P-63 Kingcobra fighter. Along with larger size than the P-39, it boasts greater combat range and considerably more speed. The new 1,500-hp. Allison V-12 engine with improved two-stage super-

charger gives increased efficiency at high altitudes. Wing shape is a little different from the P-39's, tapering equally on both edges to rounded tips. Dihedral starts slightly outboard. Armament is the same in both planes—a 37-mm. cannon and four .50 caliber machine guns.



Head-on views of the P-63 and the P-39 (below) reveal many similarities and some differences between the two Bell jobs. Increased engine power in the new plane calls for a four-bladed prop. Characteristic lines of the Kingcobra's low-drag laminar-flow wing appear in the three-view at the left







Errant Tapir Taxes Keepers' Ingenuity

When a wild animal gets out of his zoo quarters and has to be sent back, the situation calls for strategy and patience.

Nutsy, the Philadelphia Zoo's Brazilian tapir, decided to go adventuring. The keepers were hot and bothered, the onlookers were definitely interested. What to do? They began by getting him into a corner of the enclosure; then—

Photos by Isabelle Kauffeld

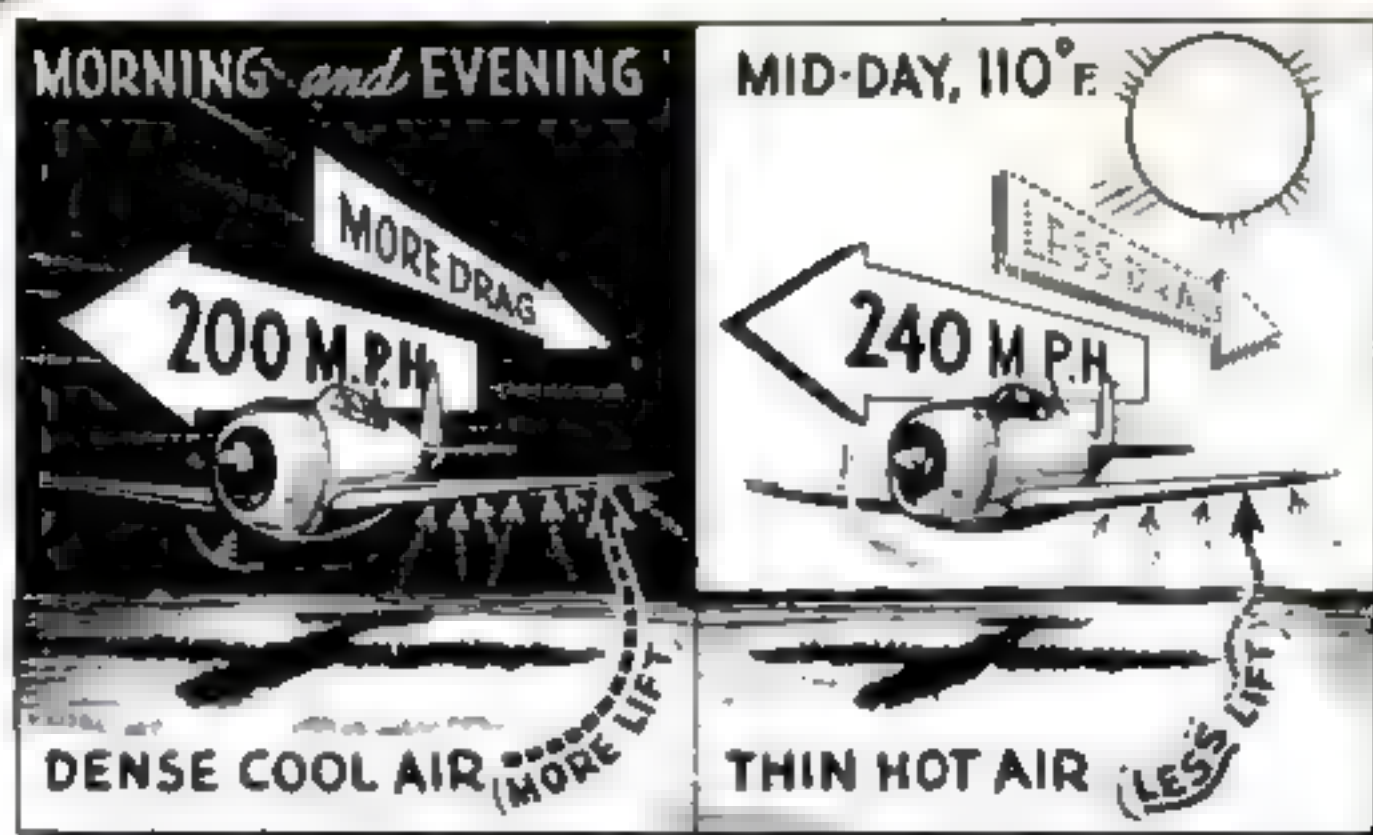


They built a stairway out of bales of hay up which they urged the capering tapir in the direction of his quarters. But liberty was sweet, and he dashed into the hippo's pool to get away from his pursuers.

"Now I've got 'em stymied," said Nutsy to himself, taking another long, fragrant whiff of freedom, but he hadn't reckoned with the zoo keepers' brains, so—

He wasn't prepared when they pulled a fast one on him. They simply drained the pool, and then gave him the bum's rush back to blighty and Mrs. Nutsy.





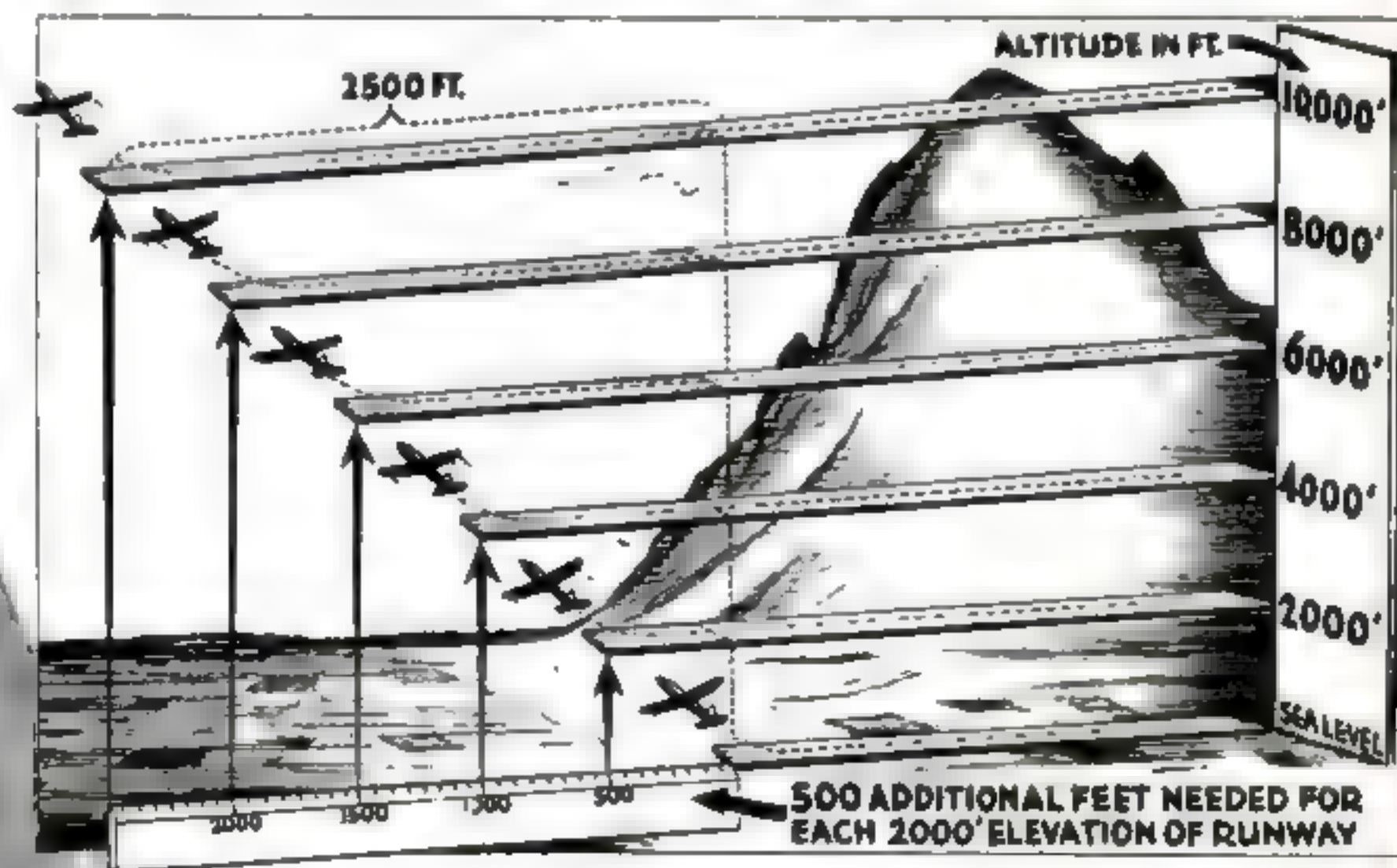
Why Mountain Airports Need Longer Runways

WHEN tomorrow's engineers build airports in the high places of the world, they will also have to build 'em long. Because of reduced air density, the higher an airport is above sea level, the longer the runways its planes will need to make a take-off. As a guide, the Civil Aeronautics Authority has laid down the following rule: for every 2,000 feet of elevation above sea level, runways must be 500 feet longer.

Another factor that will affect high-altitude take-offs is temperature. Under a broiling midday sun, a plane taking off from, say, a 7,000-foot field will encounter

little drag because of the hot, thin air hugging the ground. Yet to get sufficient lift from this same thin air, the ship will have to hit a much higher speed than if it were taking off in the cooler and denser air of the morning or evening.

Still another trick thin air plays on planes is to cause their speed indicators to "underread." Because they are built to register accurately only at sea level, indicators underrecord a plane's speed with increasing error the higher the ship flies. To adjust the error, pilots add two percent to their readings for each 1,000 feet elevation.

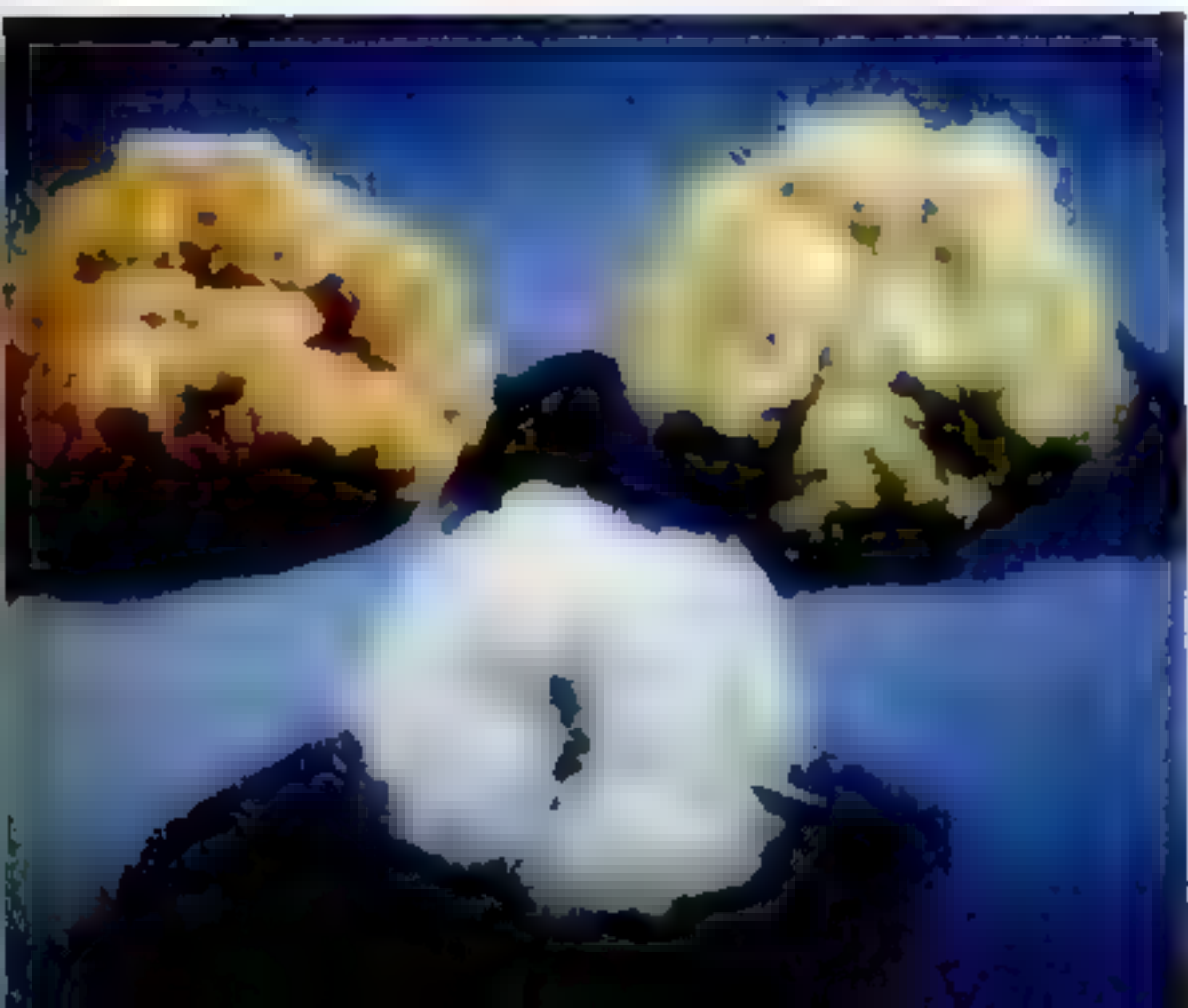
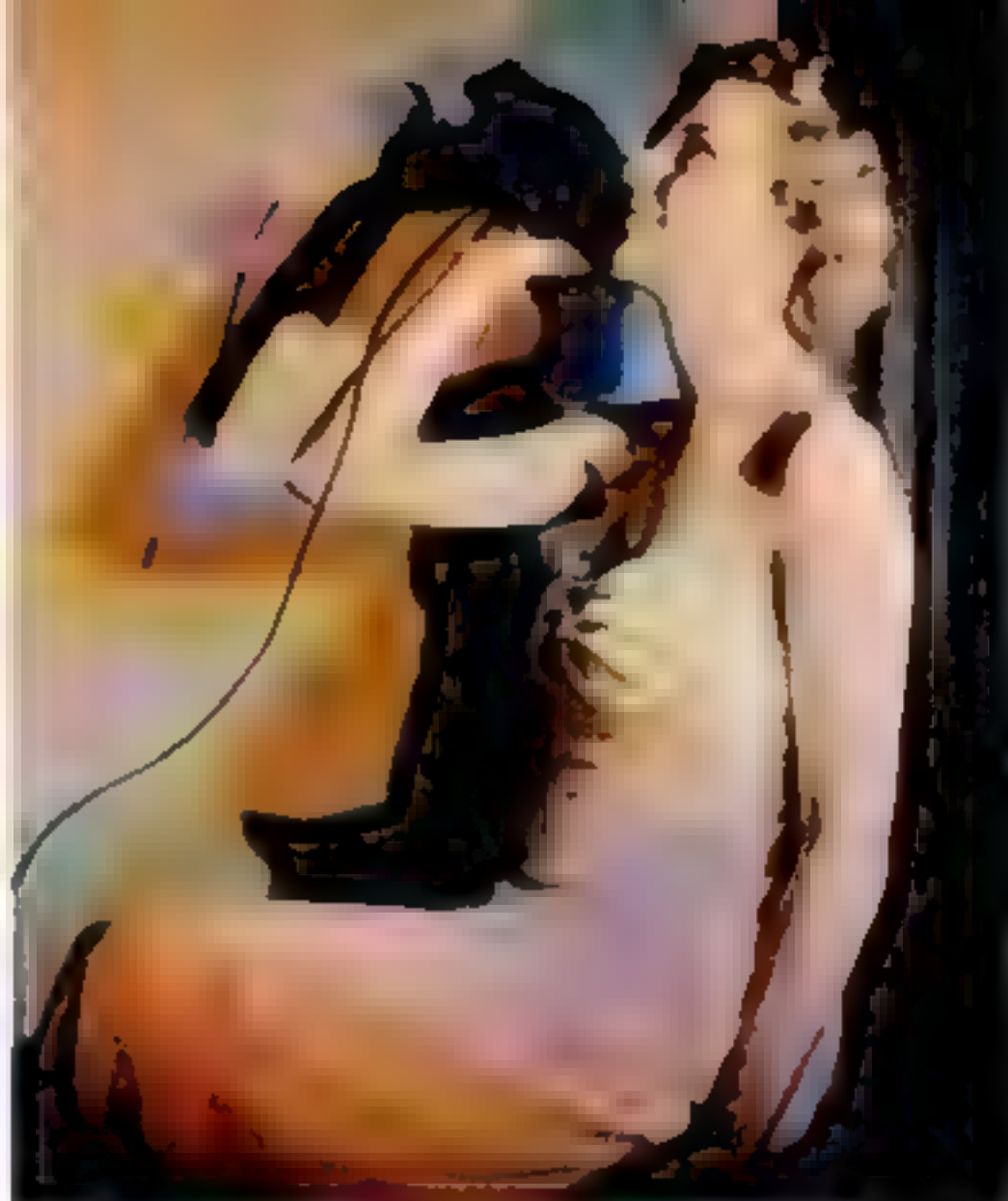


Rainbow Light Makes Striking Color Photos

By WALTER E. BURTON

USE different-colored light sources when making natural-color pictures, and you may obtain strikingly beautiful effects. Three spotlights, each equipped with a light filter of a different color, may be used for lighting a portrait (see illustration). In this case the illumination came from three spots, each producing light of a single color. The varicolored shadows on the background help to make this picture unusual. Since metallic surfaces reflect the rainbow hues, multicolored lighting has been used with Kodachrome in advertising such items as cameras.

In experimenting, try different light distances, angles, and heights with relation to the subject; also different color combinations; and try to work in some multiple shadows. As with ordinary lighting, an electric exposure meter can be used. When the accompanying shot was made, a sheet of white paper was held near the face in line with the camera, and a reading taken from the paper. Then an exposure eight times as long as that indicated for the white paper was given.



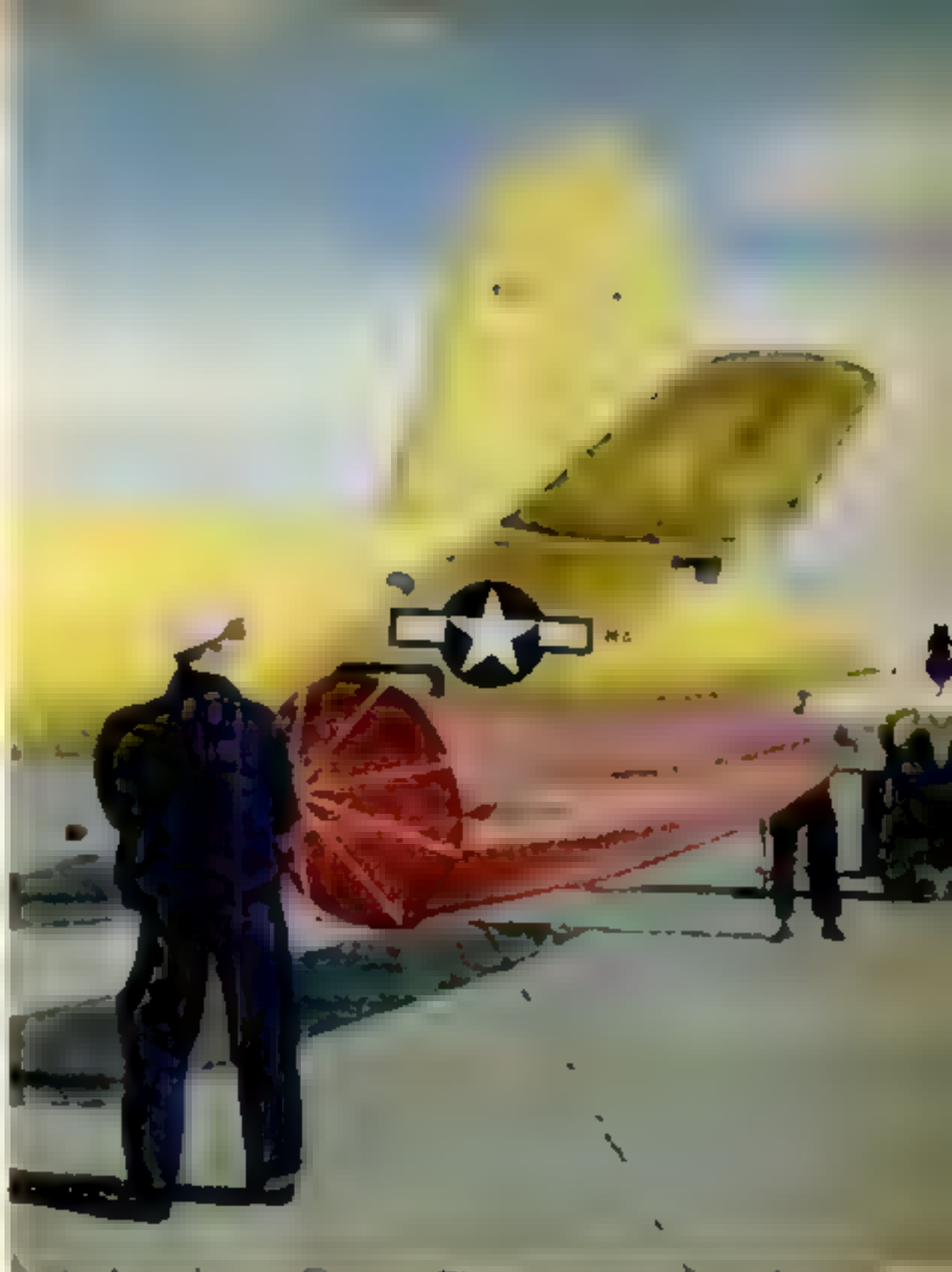
COLORLED COTTON has been propagated by the Department of Agriculture, co-operating with the Delta Experiment Station, Stoneville, Miss. Originating from sports—unexplainable freaks on otherwise normal plants—the tinted cottons have now become pure strains, and breed true to Mendel's law of inheritance. Thus far, commercial success has not been achieved, since the green cotton fades in sunlight and the brown lint is short, weak, and variable in hue. "Cottonade," a coarse wool-like fabric, has been woven from these colored cottons by Arkansas and Louisiana women.

POPULAR SCIENCE



New Towed Targets Train Navy Gunners

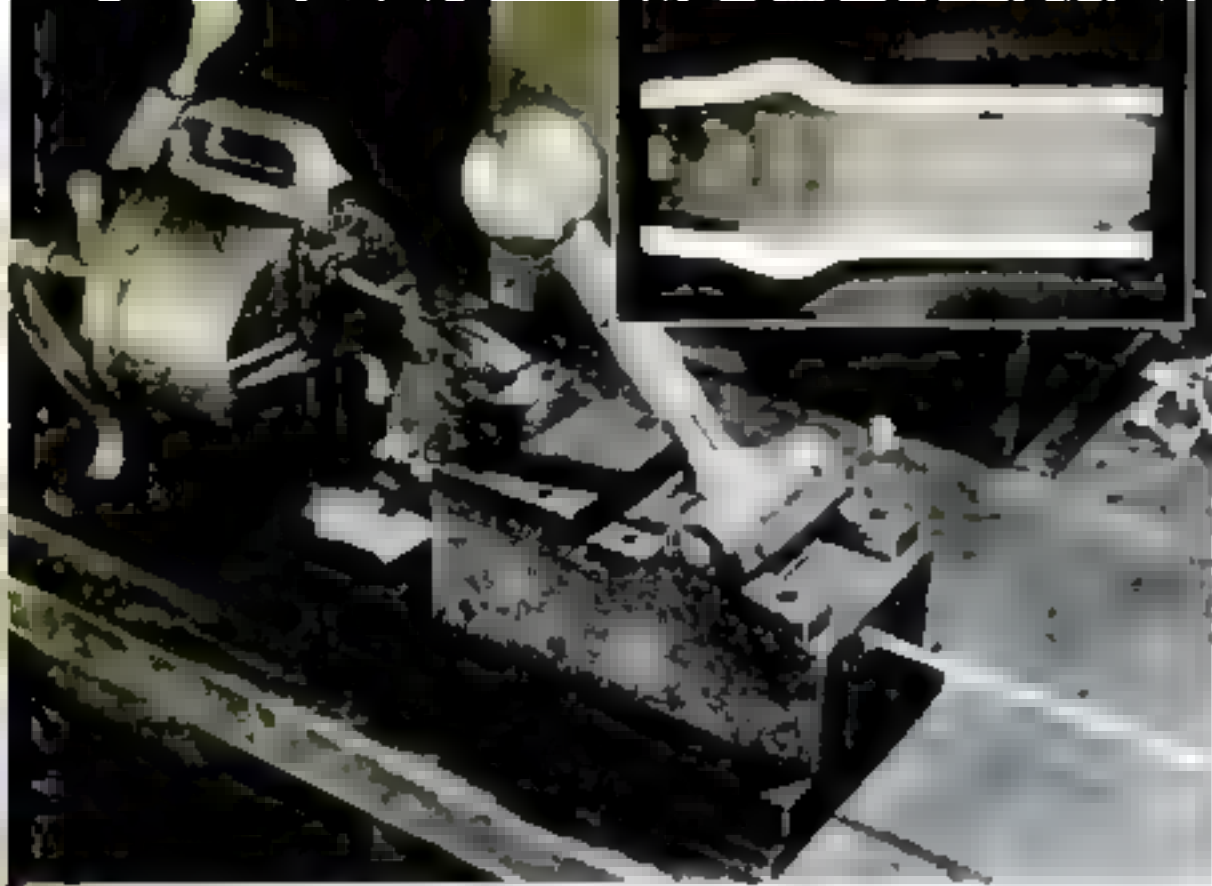
TWO new tow targets, one of plastic, the other of silk, are taking the "hit-or-miss" out of target practice for Navy aircraft gunners. The plastic target—rigid, torpedo-shaped, and more stable than the customary cloth sleeve—enables bullets to make clean holes and also retains the colored paint in which the bullets have been dipped to show from which gun they have been fired. The silk target, built like a wind sock, and also capable of retaining the bullets' colors, is released in flight through a hatch and then held open by a ring at one end. Both targets fly several hundred feet behind the plane.



Two crewmen stretch one of the new silk targets to full length before rolling it up compactly for stowing aboard the tow plane. After it has been riddled, it can be replaced while the ship is in flight.

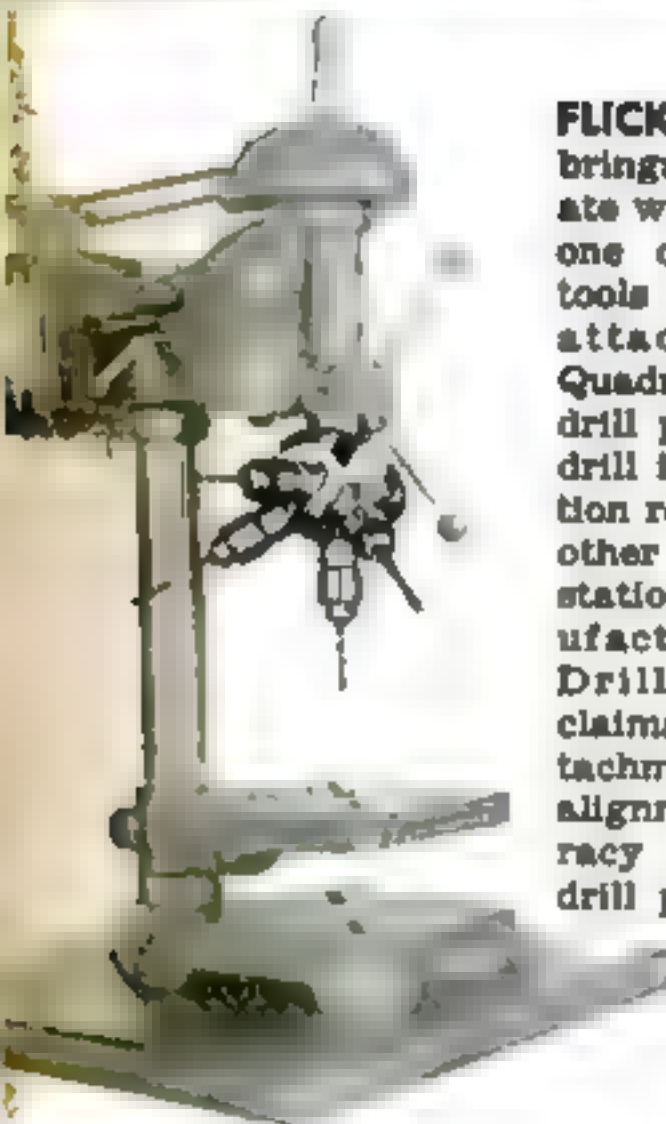
Looking something like a robot bomb, the plastic target is carried in a sling under the tow plane's tail until ready for use, when it is released and towed several hundred feet astern. Note the fins for stability in flight. To pull both this and the silk target above, the Navy uses its fastest tow plane, the JM-1.



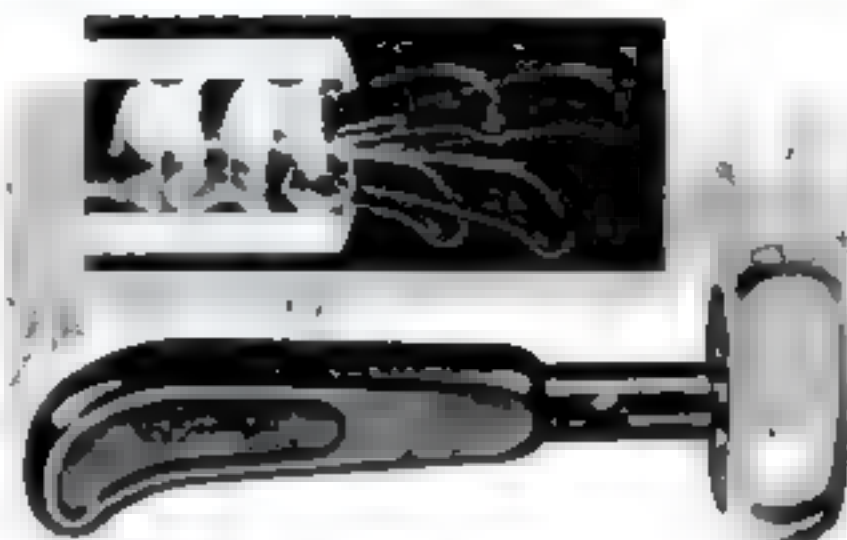


new Tools

PNEUMATIC SQUEEZER invented by Frank J. Nickel, tool-repair man at The Glenn L. Martin Company, Baltimore, Md., beads $\frac{1}{8}$ -inch tubing without the use of the conventional tools by which the bead is rolled into the metal from inside the tube. Pictures (left) show squeezer and cross section of tubing beaded by this machine.



FLICK of the finger brings into immediate work position any one of four drilling tools when the new attachment called Quadrill is used on a drill press. Only the drill in working position rotates, while the other three remain stationary. The manufacturer, Chicago Drillet Corporation, claims that the attachment maintains alignment and accuracy as true as the drill press itself.



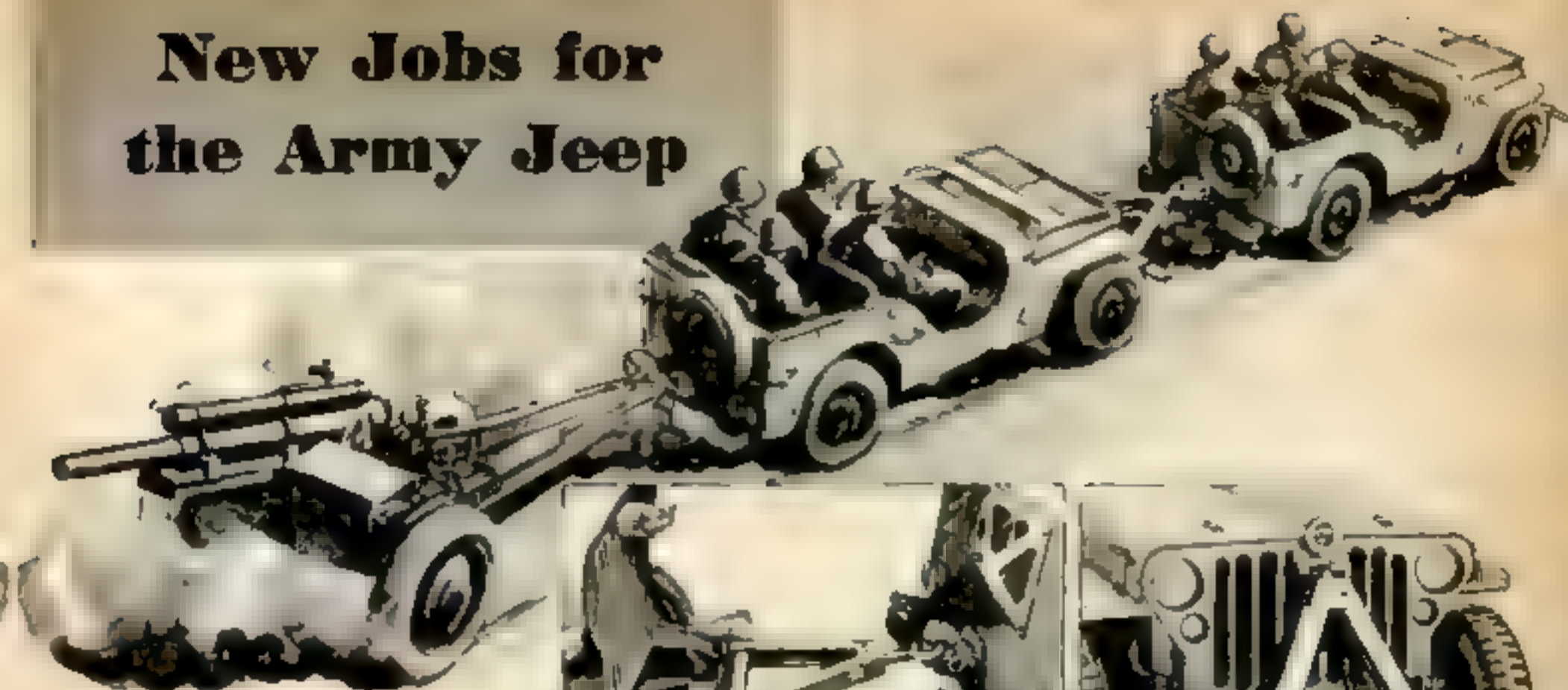
ENDLESS BELTS of the leather V type can be made as needed with tools manufactured by Charles A. Schieren Company, New York. The belting, supplied in rolls, is cut to size and placed in a lap cutter (below), which trims a feather-edge bevel on each end. Binding cement is then applied, and a clamp is attached to hold the belt until the cement sets.

IMPROVED TeBo fixed-limit type of bore gauge is now in production by the Standard Gage Company, Inc., Poughkeepsie, N. Y. A recent Standard improvement is adjustability by means of two tapered screws

acting against V slots in the insert (shown at top of gauge in picture directly above). By turning the screws, the "no go" factor can be varied within the gauge's limits and held constant to various tolerances.



New Jobs for the Army Jeep



TANDEM TOWING. Two quarter-tons, hooked together by means of a triangular coupler and reinforced pintle hooks, can haul a 105-mm. howitzer or other heavy equipment that would ordinarily call for a 2½-ton truck. The hookup is shown in the drawings above. When not in use, the coupler can be folded up in front of the radiator. Driving jeeps in



tandem as prime movers calls for extra care; in slowing down, for instance, the brakes on the second jeep must be applied first to keep the momentum of the heavy load from putting the squeeze on the middle car.



BOOTSTRAPS. Addition of an engine-operated winch capstan at the front enables a jeep to pull itself out of hub-deep mud or swampy ground. With a rope attached to a stout tree and

passed around the capstan, power is applied to the winch when the driver moves a control knob toward the rear of the vehicle. Photo shows capstan.

FOR A WIRE CATCHER the jeep has been equipped by ingenious GI's to cope with tough piano strings strung neck-high by the Jerries across highways and byways. The device consists of a strip of angle iron bolted upright to the forward bumper. It extends above the heads of those riding in the jeep, and is notched a few inches from the top so that any wire extending across the road will be caught and snapped. The jeep shown below is equipped with this and other improvised accessories.

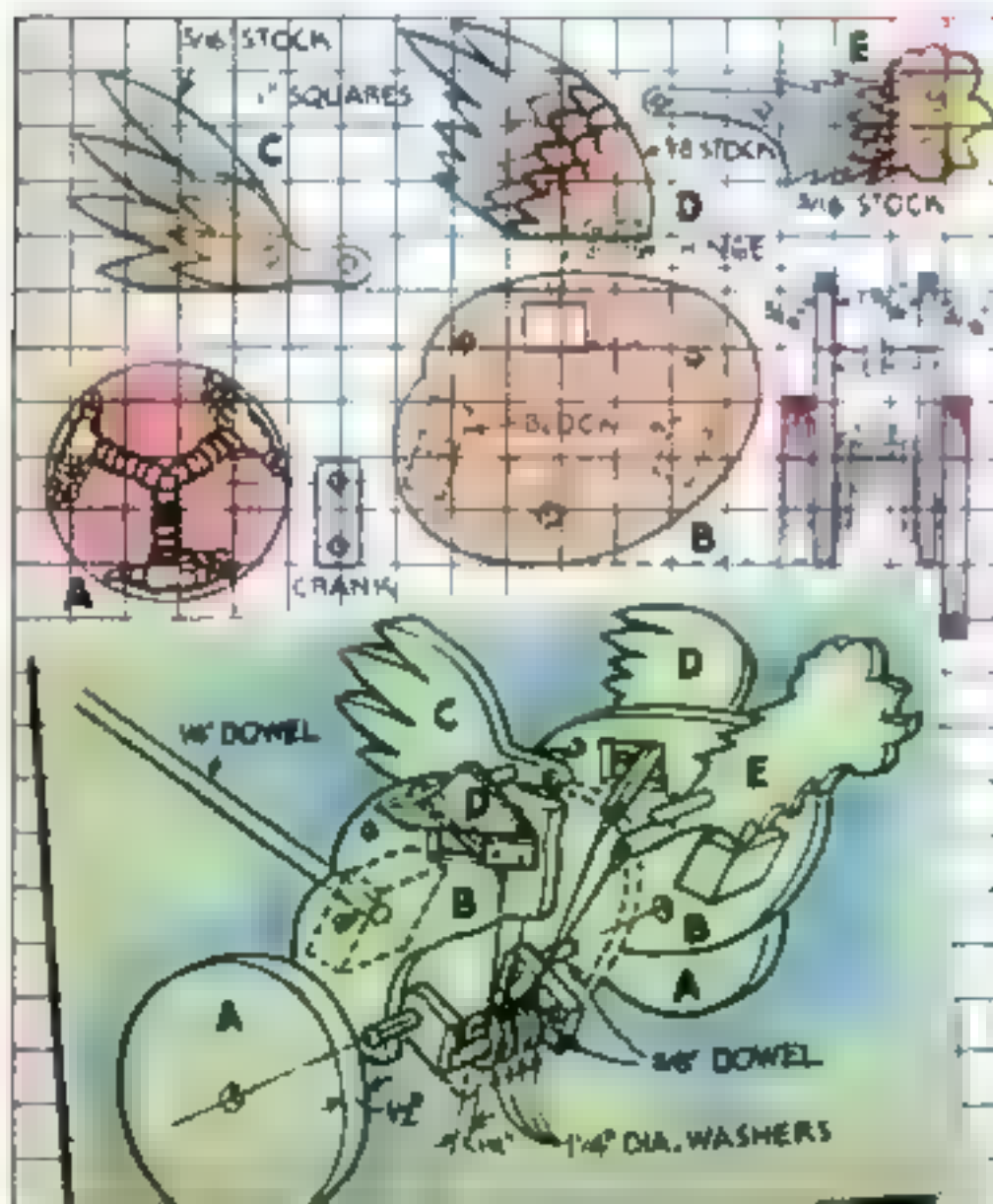
Courtesy of YANK, the Army Weekly





LIVELY ACTION TOYS YOU CAN MAKE OF WOOD

By CARL W. BERTSCH



COLORFUL and sprightly in action, these simple toys are easily made of noncritical materials in your own workshop.

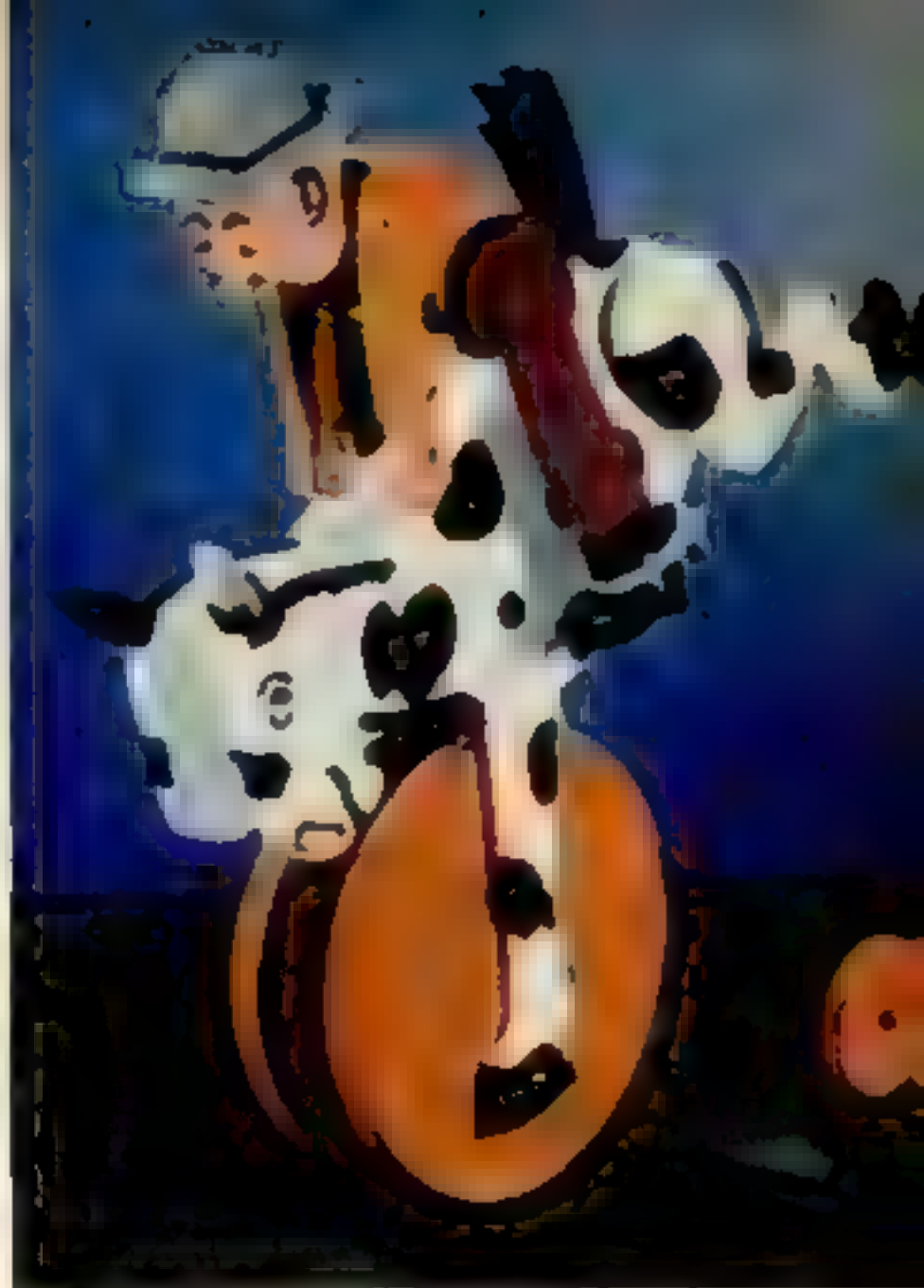
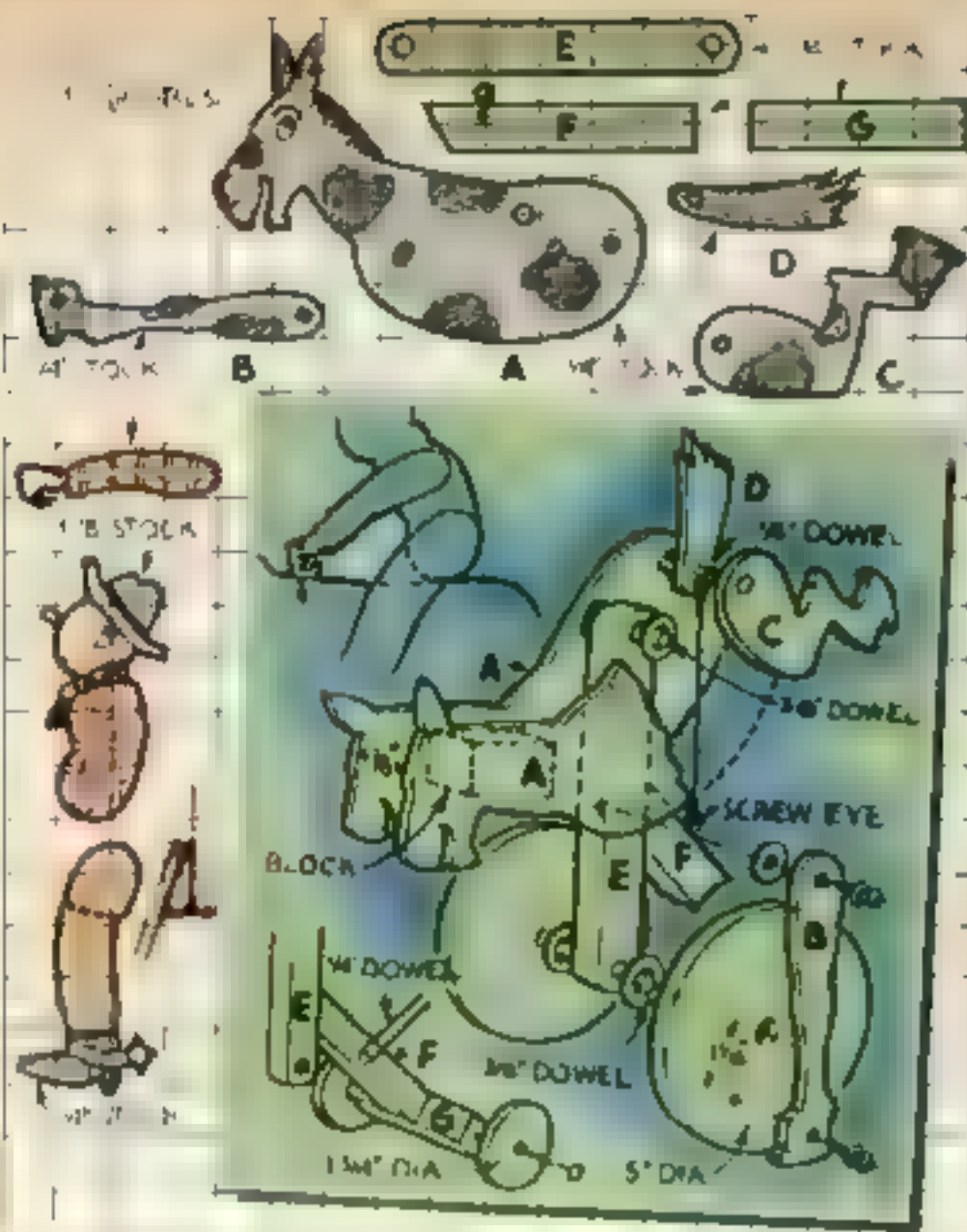
Brownie, the Hen, ducks her head, flaps her wings, and bobs her tail. Two hinges serve as pivots for her wings. Her head and her tail pivot on $\frac{1}{4}$ " dowels set into her body. Action is achieved with a single crank and four lengths of wire. Four $\frac{1}{2}$ " i.d. iron washers with holes near their edges act as bearings. Thread the wires through the holes, turn the crank to the "down" position, lift the wings, head, and tail as far as they will go, and attach the wires to them. The length of the wires is not critical because when not pulling they are slack, permitting the overbalanced extremities to fall back in place.

Pinto Pete rears, nose dives, and lets fly with his hoofs while Sagebrush Sam, riding bareback, sticks like glue. Pinto's forelegs, attached to the front wheels and to his body, act as cranks to raise and lower him. As his hindquarters go up, a fish line, attached to brace F and to the dowel that holds his tail in place, tightens, snapping his legs up in a realistic kick.

Jocko, the Monkey, rides his tricycle in high glee, pedaling for all he is worth and tipping his silly hat to everybody. His left leg is nailed firmly to his body and pivots about a screw that is fastened through a block to the tricycle frame, piece K. His right leg is pivoted at his body and is in no way attached to frame K. His right arm acts as a cam, hitting the handle bar as his body swings forward, moving up, and thereby raising his cap. His tail is a piece of $\frac{1}{2}$ " twisted cord.

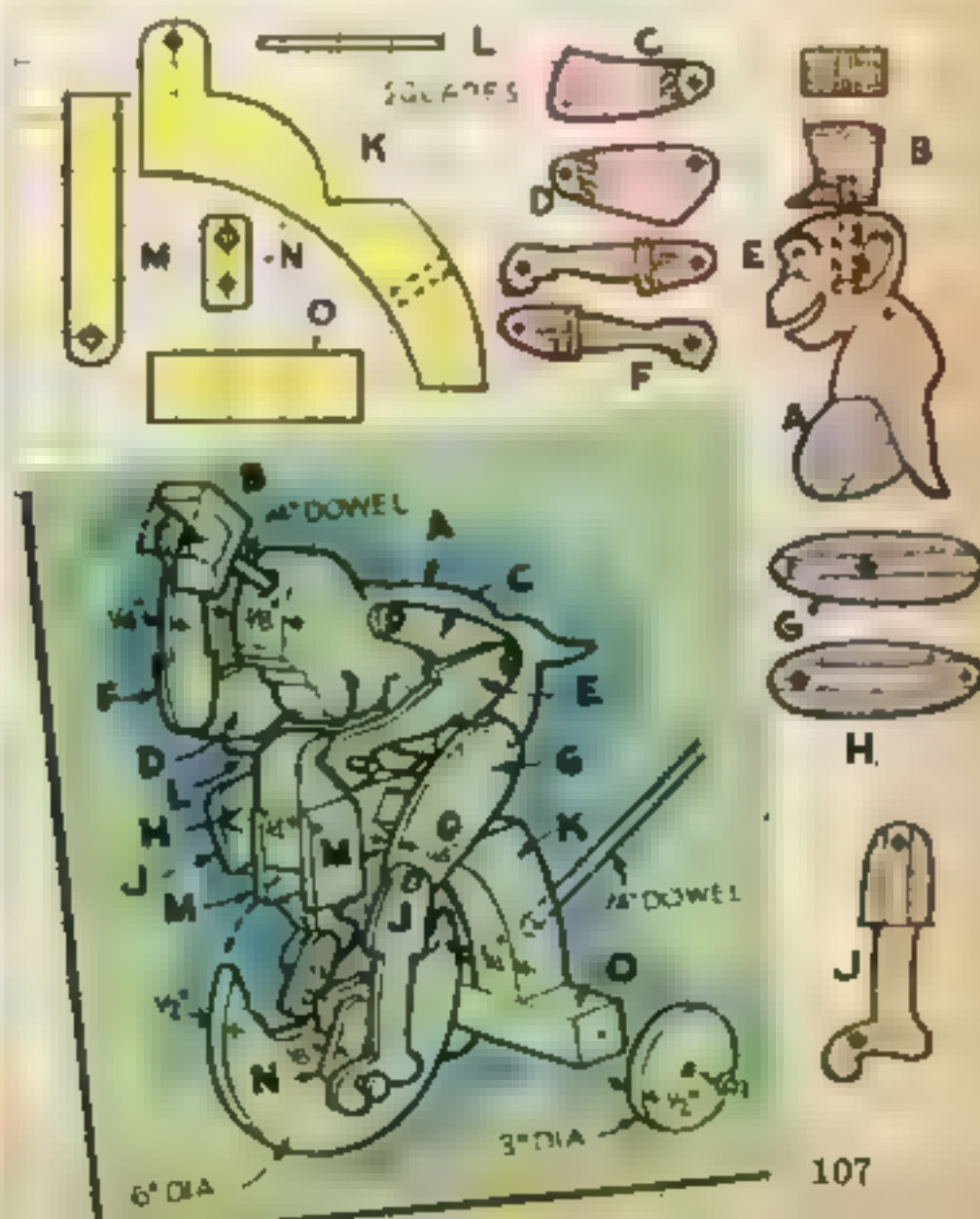
All the toys have holes as indicated to take $\frac{1}{4}$ " dowel push sticks. They may be gaily finished in the colors shown with quick-drying bright enamels.

Brownie, the Hen, will appeal to most kiddies as she scrambles across the floor, head and tail bobbing and wings wildly flapping. Use a coping saw or a power jigsaw for cutting out the pieces. Finish in bright colors, as shown, preferably using nonpoisonous enamels.



Pinto Pete, the bucking bronc, and his rider, Sagebrush Sam, proceed in a series of leaps and bounds with hoofs flying and tail waving jountily in the breeze. But no matter what gyrations Pinto essays he can't unseat his intrepid rider, who looks quite gay in his brown chaps and his orange plaid shirt

Jacko, the Monkey, is very polite, for as he pedals along he jovially tips his cap to passersby. The cap has glued to it a $\frac{1}{4}$ " dowel that slides in an oversize hole in Jacko's head. Round the end of this dowel with sandpaper so it will slide freely. Use glue and brads to fasten the front wheel, the axle, and the cranks together, boring small holes at an angle through both cranks and the axle and through the wheel and the axle, then forcing a brad into each hole to forestall any tendency to slip





SPRING SHORTAGE led Leonard N. Walters, of Douglas Aircraft Co., Tulsa, Okla., to design this tool, by which springs can be made quickly by hand. For coil springs of various types, Walters threads wire through the winder and into a hole in a drill-press mandrel. As the mandrel revolves, a spacer on the tool sets the width of the coils to produce the type of spring required.



Threaded ends on tubes used to pipe oxygen, gasoline, oil, and water are now sealed with plastic plugs of Consolidated Vultee

SUBSTITUTING plastic plugs for adhesive tape and cardboard formerly used in sealing threaded tube fittings has saved time and labor on Liberator planes. Robert D. Eden, of Consolidated Vultee's No. 2 plant, San Diego, Calif., hit upon the idea. He went to the salvage dump, reclaimed the plugs from pumps and valves, and applied them to the tubes. The resultant saving in time affects 17 departments.

Easy Does It!

YANKEE skill and plain horse sense exercised by workmen in our aircraft manufacturing plants have in many instances speeded up production enormously and saved millions of dollars. Ideas originating in "the shop" are likely to be so simple that big-time engineers can't spend the time to think of them, yet some of them have affected world history. Certainly those shown here have gone a long way toward helping us to win this war.



TIGHTENING BOLTS on hard-to-reach turret bearings in Liberator installations became simple and easy after A. E. Lyerla, a final assembler for Consolidated Vultee, developed this simple flex-shaft attachment. It consists of an electric hand-drill motor at one end and a $\frac{3}{4}$ -inch socket at the other, and supplants a hand ratchet wrench that was formerly used. Now Lyerla reaches inside the turret, snaps the socket over a bolt, and—buzz—it's tight. With 64 bolts in each turret, this device saves much time.



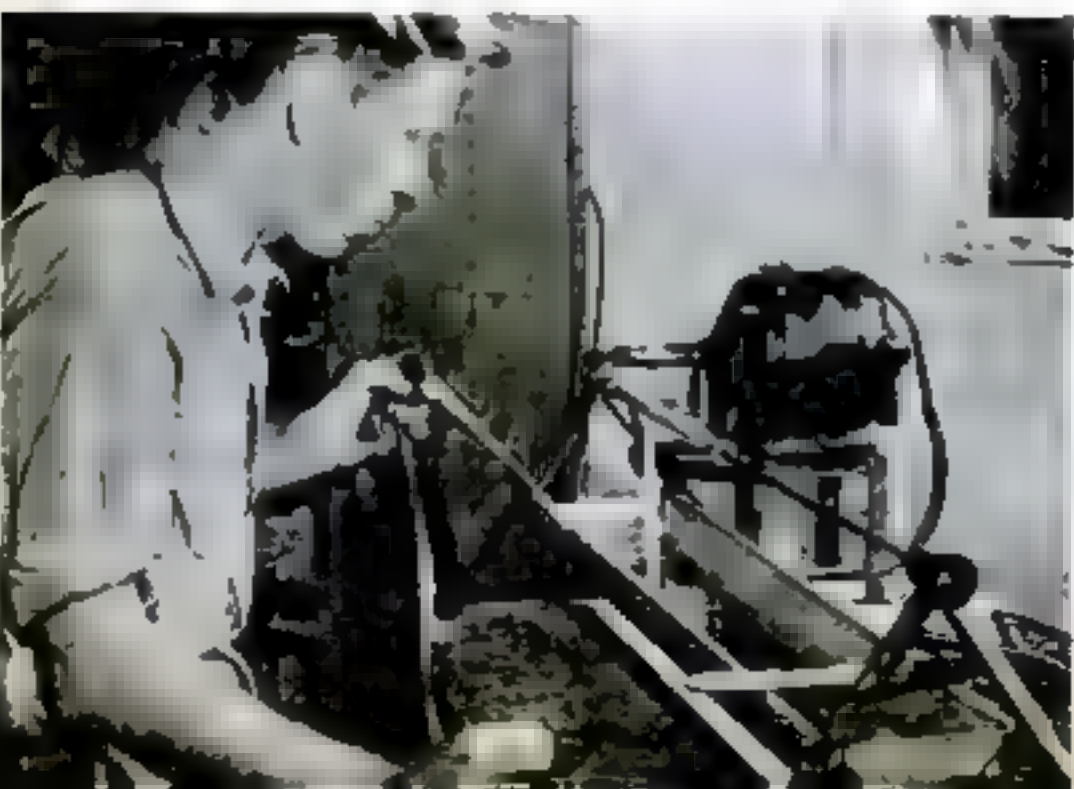
PRESSING REPLACES HAMMERING when this hand-operated tool is used to drive home the close-fitting bolts used in airplane construction. The presser, which can be operated by women, resembles a pair of oversize pliers, and is constructed so that no damage is done to bolts, web, or strut bearings. It was designed by Richard Scott, of the Douglas Aircraft Company's El Segundo, Calif., plant.



SPRAY GUN connecting a funnel to an air nozzle paints many small aircraft parts simultaneously. The operator drops the parts into the funnel and closes the lid. When the trigger is pulled slightly air rushes in, making the parts revolve. As the trigger is pulled farther, paint is introduced. Partly released, the trigger admits only air, which dries the parts. Wilborn F. Weger, painter at the Douglas Oklahoma City plant, invented the device.

HALF AS MUCH TIME as formerly is required for winding conduits from spark plugs to an ignition harness manifold when this device is used. Invented by Charles Donovan, of Pennsylvania-Central Airlines, the electrically driven machine wraps conduits with airplane linen tape to keep out moisture. Tape is fed through a trough of dope and onto the revolving conduit.

SIMPLE WAY TO STRENGTHEN electric plugs was figured out by Charles W. Silver, electrician in Douglas's Oklahoma City plant. He built a jig to hold the plugs upside down, and poured a hot-tar compound around the connections, thereby sealing them and preventing shorts caused by the entry of drilling particles. The scheme greatly reduces breakage and blowouts.





Sandblasted glass plaque was finished off with grinding wheel



Perforator (above) pierces design outlines for stencil. Below, glass is covered with "resist paper" ...



THE process of carving glass by means of a sandblast has been known for years, but so exacting are the requirements for producing really fine art by this means that only a few artists can meet them. Among these is David Harriton, of New York, whose work and methods are illustrated on these pages.

In Harriton's big studio close to the East River he has rooms for designing, preparing the glass, and sandblasting. Here he produces murals, windows, wall plaques, screens, and similar objects—some of them clear, others backed with color that shows through either frosted or transparent glass.

Carving Glass with Sand

... protecting areas not to be blasted, after which design is "pounced" on with a charcoal-filled bag





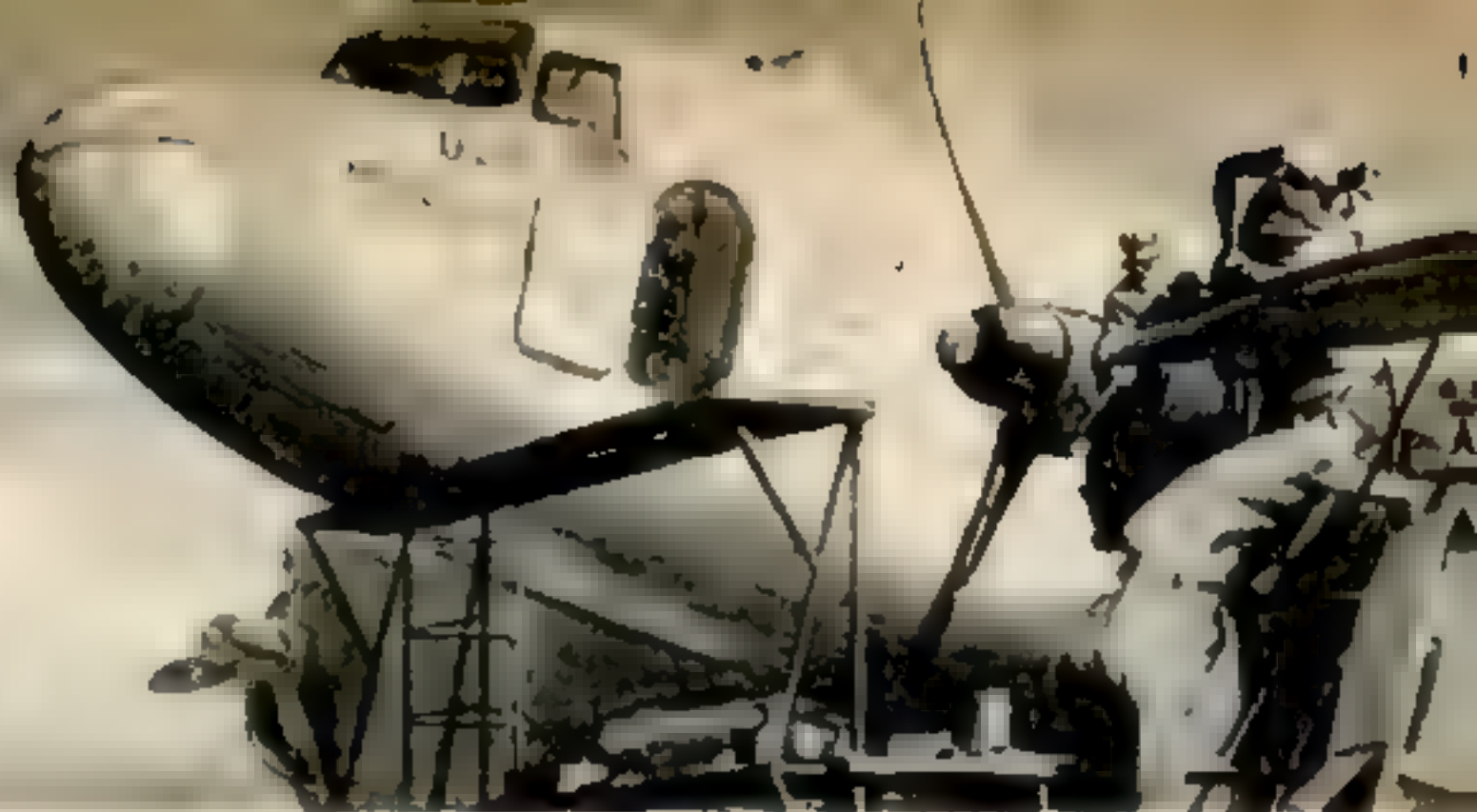
Cutting resist paper with stencil knife prior to sandblasting. Paper is pulled up during blasting.

Artist has completed about half his work with the nozzle. The blaster employs Aloxite as an abrasive.



WONDER PLANE *of the* PACIFIC

Drawings by
FRANK HUBBARD



"Old Miscellaneous" is the oldest lady in the service of Lt. Gen. George C. Kenney's Fifth Air Force. First Douglas C-47 transport to go to the Southwest Pacific, she has worn out 12 engines in her 2,000 missions through tricky weather over desert and jungle.



On supply runs to Darwin, she had to cross the famous "Never-Never Land" of Australia's mysterious desert. On these trips, her pilots and navigators charted courses for new air maps now in use.

Running to advanced air bases, she considered it a treat to land on a field that didn't have at least one good-sized bomb crater.

When the Japs threatened Wau, the Old Lady helped rush 3,200 troops across the rugged Owen Stanley Mountains of New Guinea in 48 hours! Then there was equipment to fly in.





Men were landed on airfields that were under constant fire from the Japs. On one occasion, Australian troops dragged 105-mm. guns out of the belly of "Old Miscellaneous" and then started blasting away at Nips who were dug in at the other end of the airstrip.



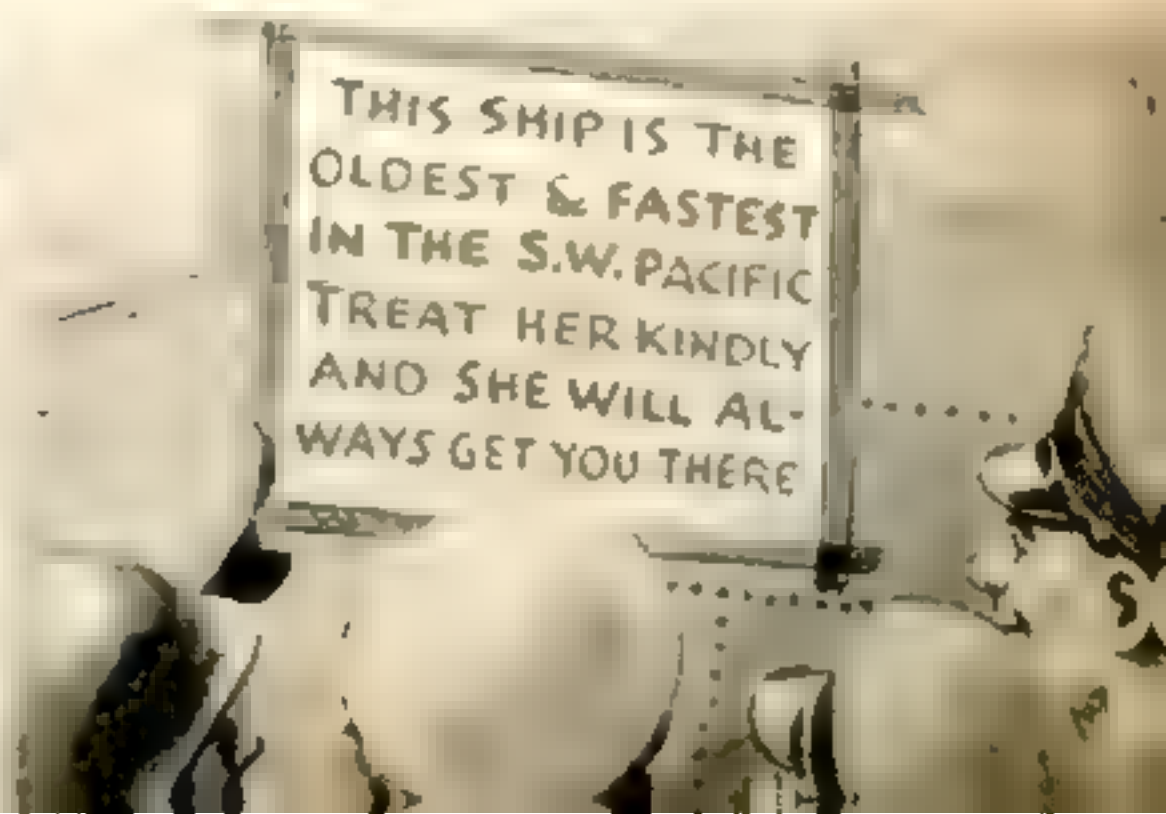
To back up the Australian push from Wau against Lae and Salamaua, supplies were dropped daily in New Guinea jungles.



When MacArthur pushed the Japs back along the north coast of New Guinea, the Old Lady took troops of the 32nd Division to Buna.

If every one of her 200-odd pilots had put his mark on No. 2, her nose would look like this.

On her transfer to the Troop Carrier Command, "Old Miscellaneous" carried this sign. Now, like any other old soldier, she's home on leave.





HOW ARMY MAKES

BEHIND the weathered facade of one of yesteryear's famous southern California movie studios, men of the Army Air Forces are re-enacting real-life dramas for the cameras these days. They play at make-believe for a purpose. On their techniques may depend the lives of a crew of a "ditched" bomber. On their ability to put over a safety message may depend the well-being of a pilot whose engine conks out on take-off. Sometimes the locale changes. These AAF men will act their roles on the California sea-coast or on an inland desert. Whatever the site, the movie is designed to educate AAF audiences in the complex procedures necessary to winning the war. The actors do their stunts for the First Motion Picture Unit, in Culver City. In two years they have participated in 150 training, orientation, and documentary films. Every month, ten production crews turn out more films than any major commercial studio.

With a sharpshooter at his back to protect him against enemy snipers, this cameraman shoots battle-action close-ups for an AAF training film

Camouflaging is taught with colored cartoon strips in which the chameleon hero, Yehudi, keeps changing his spots to show how easy it is for him to "get lost" in a colored background

**Cameramen in uniform,
working in the studio and
on the battle front, shoot
films that train airmen to fly,
fight, and survive crack-ups.**

**By
ANDREW R. BOONE**

Photographs by
First Motion Picture Unit,
Army Air Forces



MOVIES TO TEACH AIR-WAR SECRETS

Suspended from blackened wires, miniature B-17's, their electrically rotated props whirling in perfect synchronization, "fly" through synthetic fogs to land on indoor runways; colored cartoons demonstrate the necessity for adequate camouflage to protect parked planes and ground installations; animated drawings teach troop-carrying transport pilots how to land on foreign soil on split-second schedule. Supplementing studio-made sequences, Combat Camera Unit cameramen fly with the troops, photographing approved techniques of experienced pilots, paratroopers, glider troops, mechanics, and gunners. Cut into finished pictures, these scenes bring a deadly realism to the celluloid documents which prove to every man who views them the importance of performing his job correctly the first time. Air warfare does not permit second-guessing. In combat, you don't get another try.

When FMPU was organized in July

A miniature illustrates the landing of a B-17, while, below, cameramen use the real thing to show how to escape from a "ditched" Fortress



1942, our Air Force was just beginning its tremendous expansion. The first production was "Learn and Live," a six-reeler covering safety lessons for pilots. FMPU had taken on a gigantic job. It was to play a vital role in preparing the Air Force for total war. Men must learn not only to fly com-

plex aircraft, but also to save their lives if forced down on the sea, in a steaming jungle, or on sizzling desert sands.

Perhaps the most important series yet undertaken is made up of several films covering the Boeing B-29 Superfortress. Three are unfolding at the moment. "50-Hour In-

"Land and Live" film series prepares flyers for forced landings



In shooting a picture to show desert-grounded flyers how to survive until rescued, the director, to make sure the above scene would have sufficient realism, had a B-24 bomber hauled into the studio and sand spread thickly over the sound stage before he set his soldier-players to acting out their grim roles.

Desert life becomes almost easy with a bowl of gnat-seeked sand to cook an end huddle around at night, and parachute "blinds" to take the sting out of the midday sun.

A parachute thrown across a jungle stream makes an excellent trap for fish, which the flyers can then spear native-fashion with sharpened sticks.



spection," "Emergency Procedure," and "The Flight Engineer." Uninspiring titles, these. But the B-29 was built from the drawing board to do a long-range blasting job, and it was up to the movie makers to film the great plane in detail. Three crews, dispatched to the Army Air Base at Amarillo, Tex., took over the task. When they finish, the inspection film will show in close-up every move, from tightening the tiniest bolt to checking every tension point; "Emergency Procedure" will reveal to every crew member what his role will be if two engines conk out on take-off or a belly landing becomes necessary; the flight engineer will learn the details of his complex panels even before he sets eyes on a Superfortress.

Other films will cover the B-29 like a blanket.

It is to be expected that B-29's will be forced down on the sea, on desert lands, or in jungles. The "Land and Live" series, made with B-17's, B-24's, and B-25's, covers all these eventualities. Thousands of Yank airmen who have seen these pictures and heard the explanatory narrations undoubtedly have lost their fear of forced landings, no matter where they may alight. For they know not only how to come down safely on water and unfavorable terrain, but also how to protect themselves against disease, live off the land, and find their way toward civilization.

Bomber crews have little time to rehearse



Having to ditch their plane, most of the crew sit or lie on the floor and brace themselves for that awful moment when they hit the water.

Lost shoes are no problem if a flyer still has his 'chute. From it he can fashion wrappings which he can stuff with soft moss for padding.



In this scene from "Ditch and Live" the pilot is shown at the moment of impact—a moment no flyer wants to pass through twice. Note splashing water on the window.

Jungle version of a "hot foot" is to burn a tick out of a man's body with a cigarette. It's painful, but better than being infected by the tick's getting under the skin.





The jungle offers rich pickings of a wide variety of fruits and herbs. But it isn't always easy to know which are edible and which are poisonous. Training films shot in Panama show a flyer how to order a jungle dinner and how to select the vines that will provide him with fresh water with which to wash it down

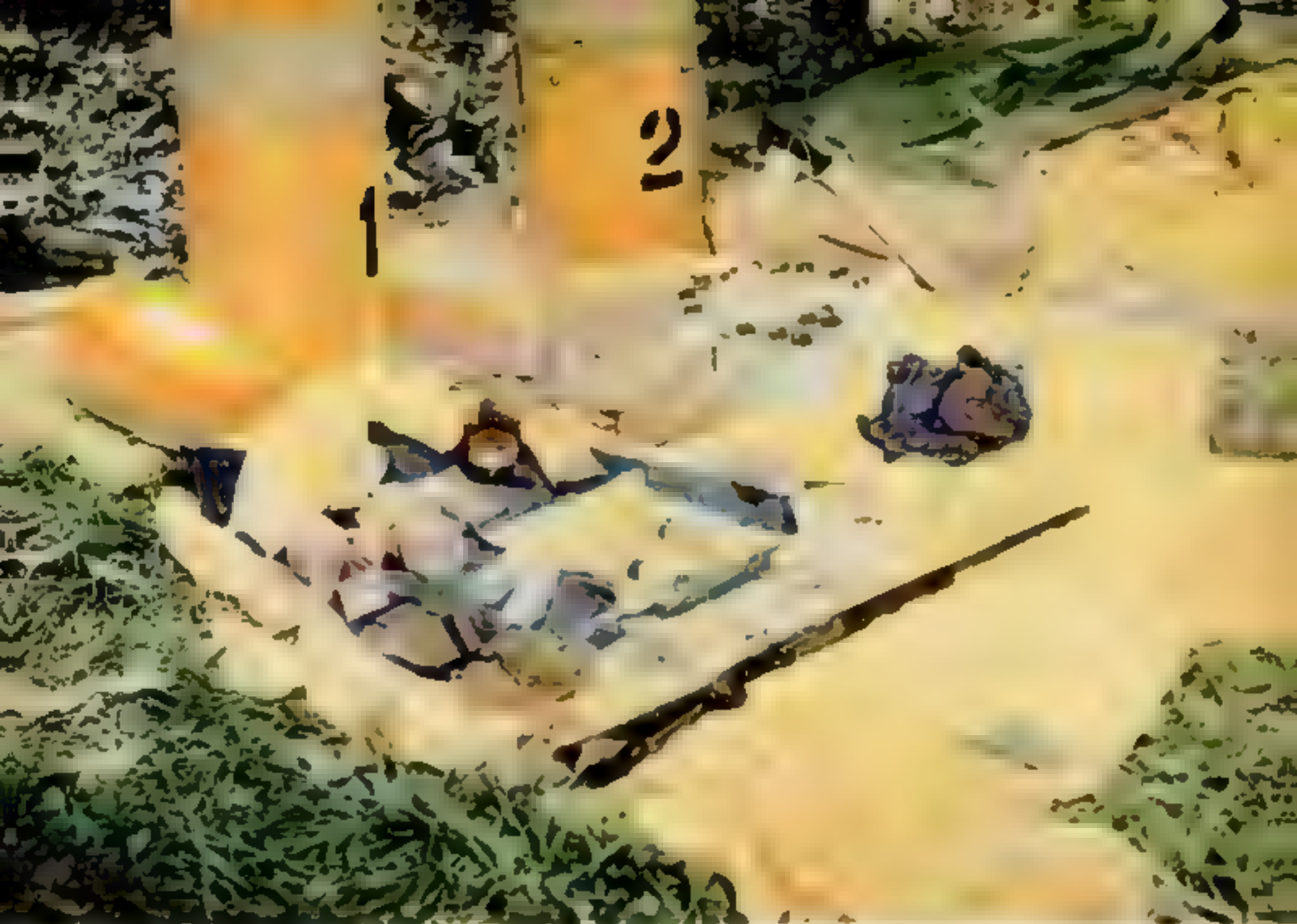
what each man will do when a Fort or Lib goes down at sea. Yet they must be prepared if they expect to come out alive, for these big land planes may disappear in 30 short seconds (P.B.M., Nov. '43, p. 84).

When "Ditch and Live" went into production, three companies started shooting simultaneously. Off the southern California coast, one director sent a miniature Fort crash-landing repeatedly into the blue waters of the Pacific, providing realistic long shots and close-ups to tie in with preparations inside the plane and actual escape. For those interiors, a second director set up at Culver City a full-size mockup of a B-17. This plane came apart like a jigsaw puzzle, permitting shots from all angles as the camera showed the crew jettisoning waist guns and other equipment likely to break loose on impact, and taking safety stations. Down on California's famed Balton Sea a third Fort, weary from long service, trembled under the impact of rushing feet as another crew flung their folded rubber life rafts through the top hatch and climbed across the wings to launch them. In due

course, this Fort sank, tail high, while the crew swiftly paddled their rafts to safety.

Two Liberators drew the starring assignments for the demonstration of a desert landing. For three weeks, a camera crew sweated it out on the California desert, grabbing location shots. On an FMPU stage, the second Lib stood, smashed and battered, on the sand-covered floor, while its crew spread parachutes over the trailing edge of one wing as protection against the sun; built signal flares from sand-and-oil-filled water tins; doctored rusty water with halazone tablets; and made plans for two of their number to navigate by the stars toward a distant post in search of help. A miniature Lib appeared on a tiny desert near by so that the camera might record long shots of this dramatic scene. Yes, dramatic in the true Hollywood tradition. But it tells a story that will save lives.

A B-25 Mitchell may come down in the jungle, shearing through trees covering some hillside. The crew will pick out the best path to get down, clipping off the wings perhaps; but they'll ease the fuselage be-

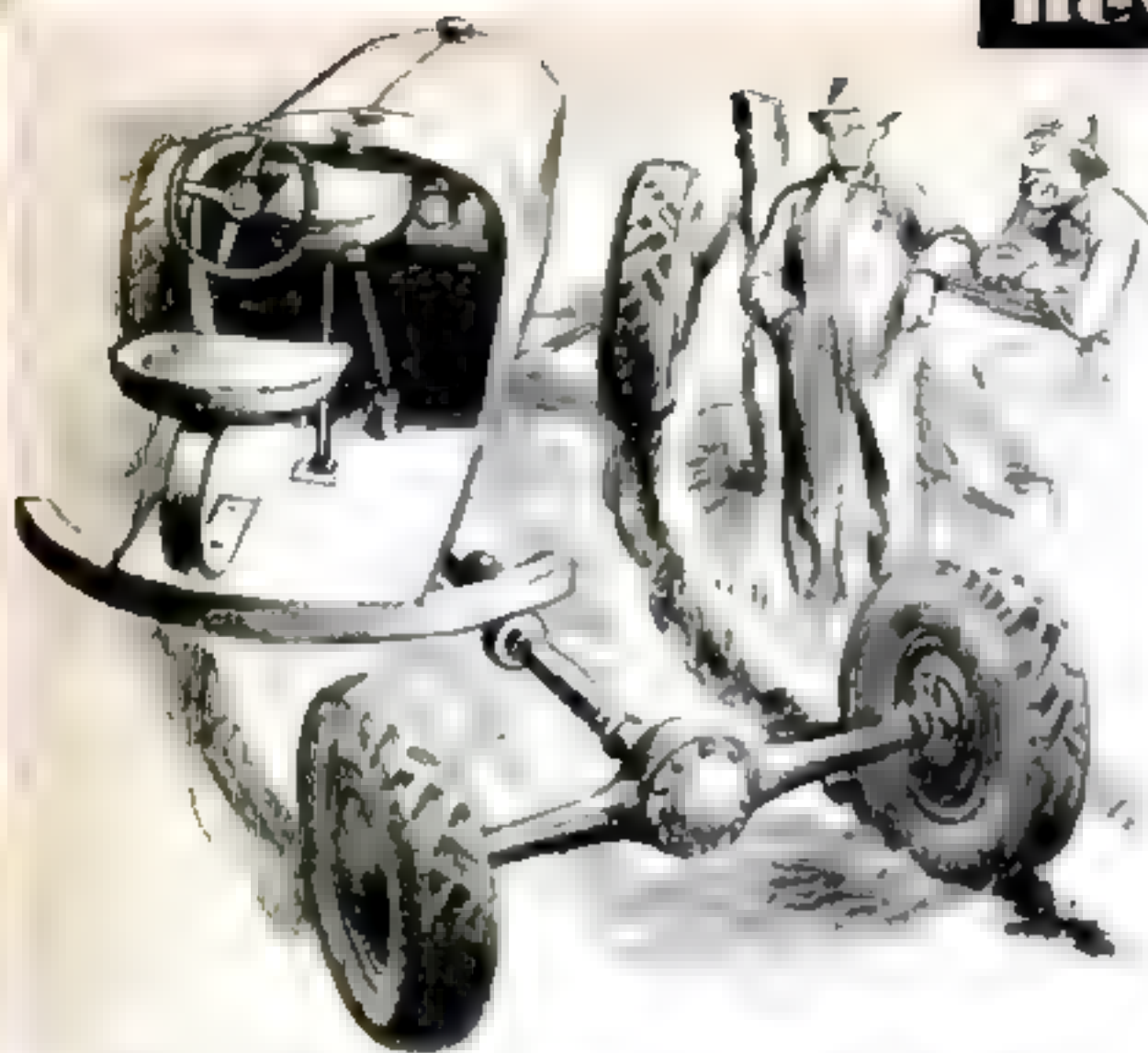


Everything a grounded flyer may need—food, water, medicine, a knife, and even a shotgun—is contained in this emergency kit. With equipment like this, and with the information they get from the "Land and Live" series of films, flyers soon lose their fear of suddenly being plopped down in the middle of nowhere

tween the trunks. They won't need to eat grubs and worms to survive, either, for such a unit battled the jungle 90 miles out from Panama City for two full months, rehearsing, then acting out for the cameras every necessary detail of life in the raw: spreading a 'chute across a stream and catching fish on sharpened branches; killing insects burrowing into the skin, with lighted cigarettes; studying the manual, eating these fruits, avoiding others. They spread signals to attract searching planes, made bamboo rafts, and followed the streams to the sea-coast. According to plan, these and many other invaluable suggestions contained in FMPU training films virtually guarantee safety for every man who gets to the ground alive.

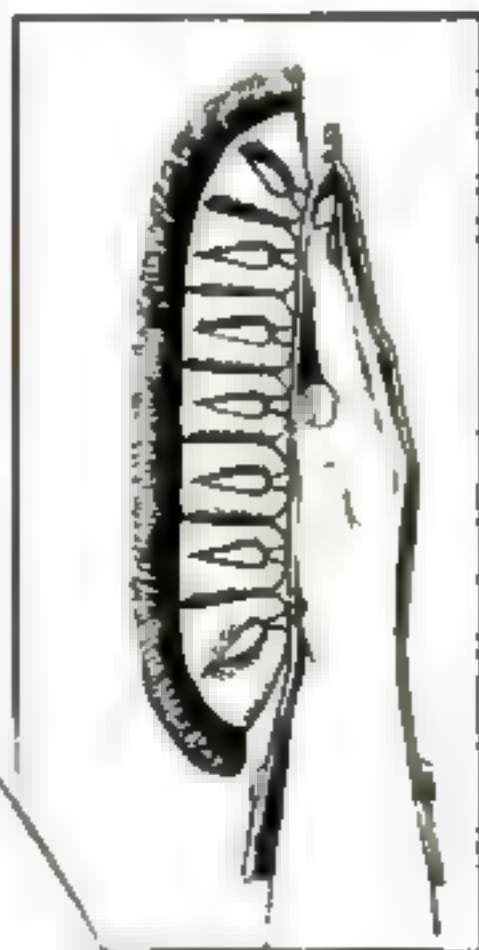
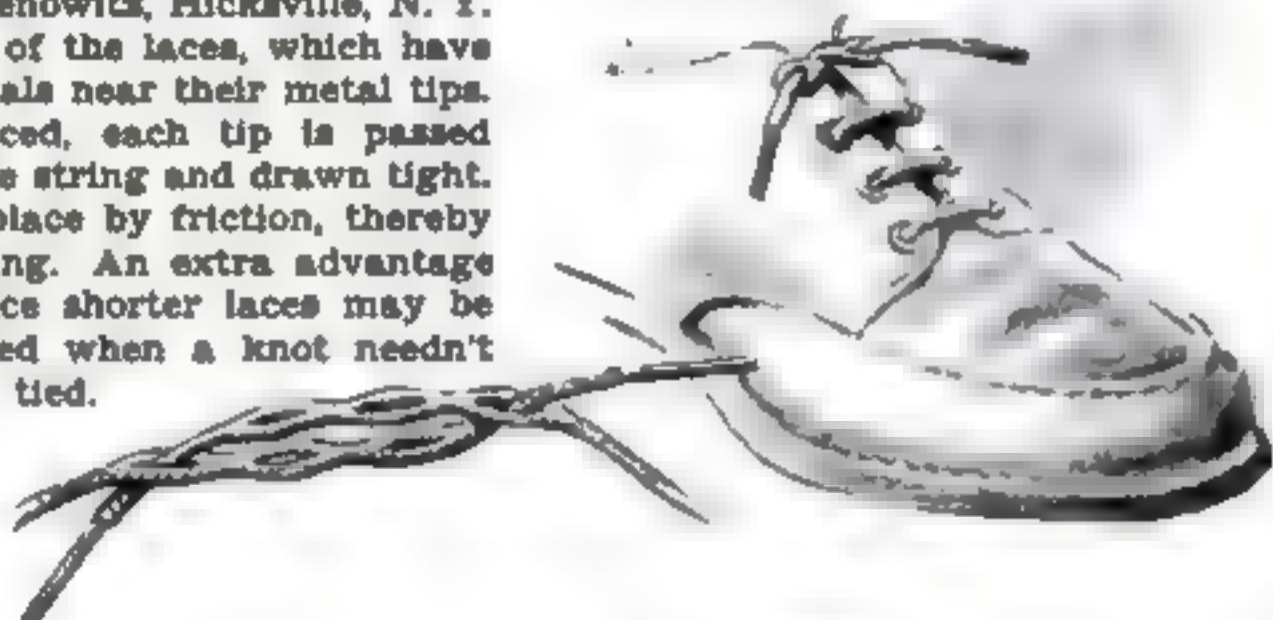
Flyers aren't the only ones who get film instruction. Ground-crew mechanics, who have to be able to doctor almost any kind of plane in jig time, learn the tricks of the trade by watching "close-ups" of experts at work. These two-crew men are doing a hurry-up job on an AT-11 twin-engine transitional trainer





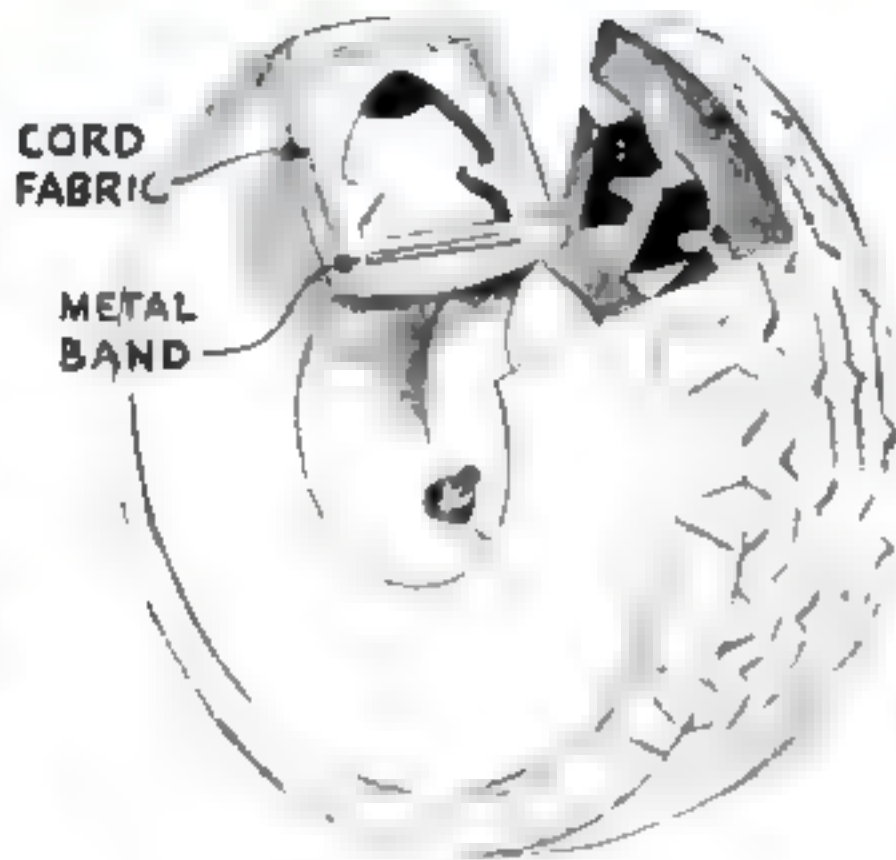
HIND-END STEERING of a four-wheel-drive tractor is achieved with the recent invention of Leon Champion, of Marne, Mich. The engine is conventionally located forward, while the transmission gear box is directly above the center of the chassis. A multiple chain drive is connected with the master gear of the two drive shafts. The forward wheels are fixed, but the rear wheels can be swung through a wide lateral angle so that they follow exactly in the tracks made by the fore wheels. The inventor says that his tractor can be built from standard automobile parts.

NOT A KNOT is necessary if you use the shoe strings invented by Aaron Benowitz, Hicksville, N. Y. The trick is in the weaving of the laces, which have slots at short, regular intervals near their metal tips. When the shoe is fully laced, each tip is passed through a slot in the opposite string and drawn tight. Thus the laces are held in place by friction, thereby eliminating the need for tying. An extra advantage is a saving of material, since shorter laces may be used when a knot needn't be tied.

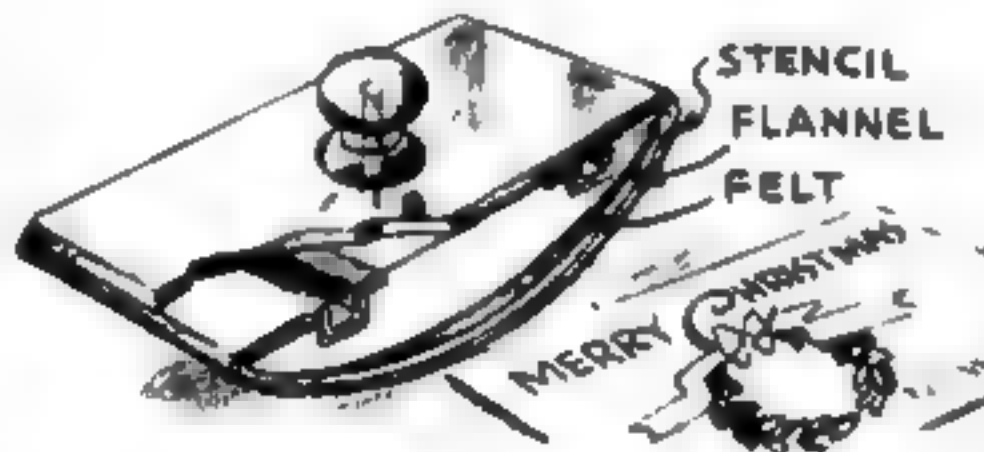


CLEANING MITT designed to stand up under continued use in washing, polishing, and dusting has been devised by Elmer T. Cox, Powell Station, Tenn. The pad, which fits glove-like on the hand, is adapted to various household uses, as well as the conditioning of automobile surfaces. It is constructed of looped fabric sleeves so as to provide a soft and absorbent working surface made up of the exposed ends of the sleeves, which are filled with twisted cotton or similar twine. Under all normal working conditions, the inventor claims, the mitt will retain its feather softness for a prolonged period.

POPULAR SCIENCE



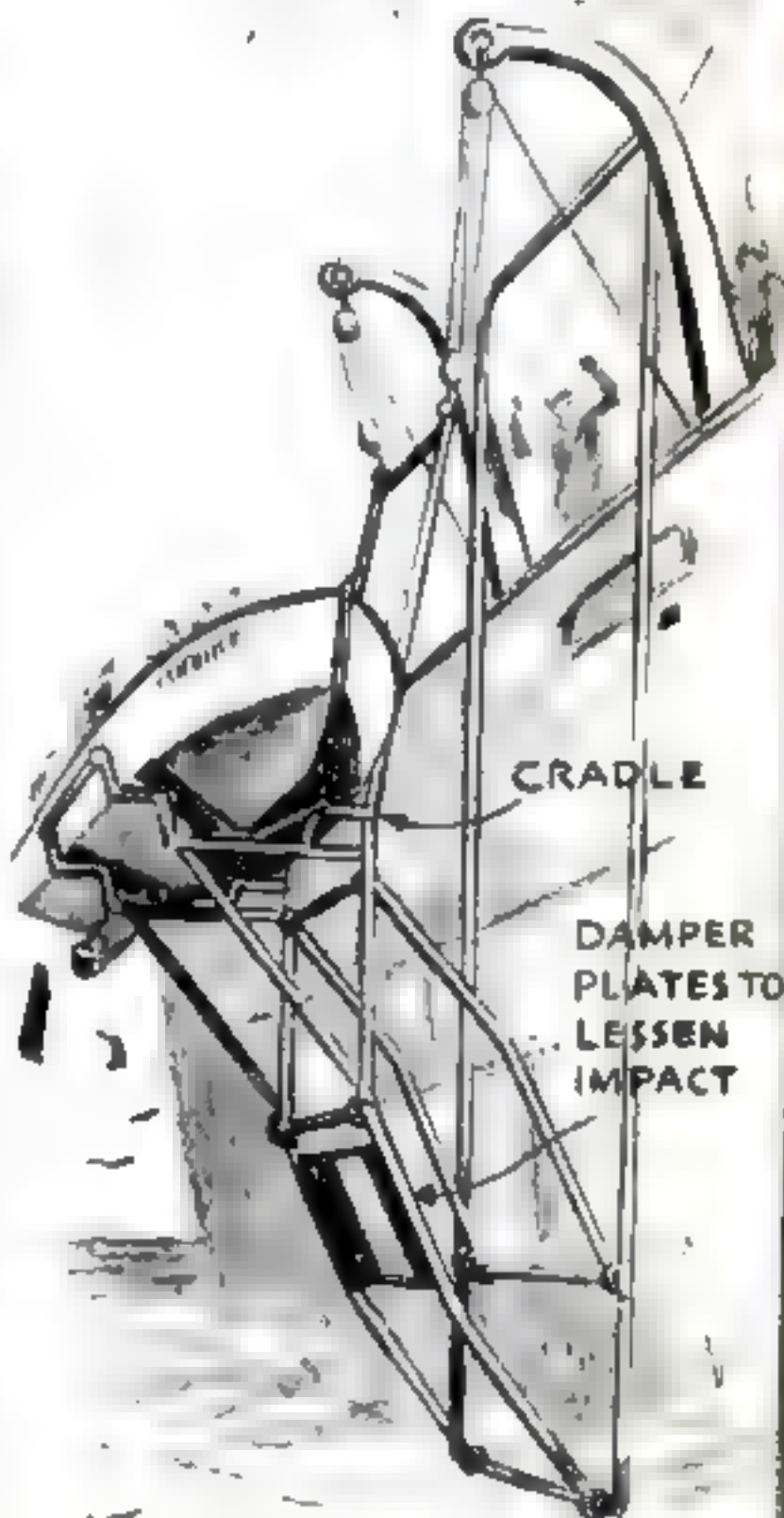
TOUGH TIRE. A puncture won't get this tire down because it's an efficient combination of the pneumatic and cushion types. It was originated by Paul O. Pfeiffer, of Akron, Ohio. It is planned to take the place of pneumatic tires, on military airplanes or war motor vehicles that are liable to puncture by bullets or exploding shells. The inventor designed the tire for normal operation at a low inflation pressure, with the load partially sustained by the air and partly by transverse tension webs. The latter are capable of maintaining the shape of the tire for a considerable time after a puncture. The tire may be made entirely of rubber, or reinforced with cord fabric. It may also be used as an inner tube for the usual pneumatic-tire casing, in which event it is molded and vulcanized to fit. In the latter case, the metal reinforcing band may be left out and the internal ribs omitted.



HAND MIMEOGRAPH. Shaped like a rocker desk blotter and operated in a similar manner, this handy little mimeograph, patented by Benjamin Gold, New York City, is adapted to the easy reproduction of messages on post cards or small sheets of paper. The stencil, ink pad, and necessary packing are clamped on with a screw device operated by the knob handle.

SAFER, QUICKER LAUNCHING of small boats from ships is the aim of the device originated by Harrison C. Hartzog, Port Lavaca, Tex. The boat is supported in a skeleton cradle extending outward from an articulated metal frame normally held in folded position against the ship's side. When it becomes necessary to launch the boat, the whole frame is lowered and swung outward on its hinged joints. The boat is released as it reaches the water a safe distance from the hull of the ship. Except as influenced by possible wave motion, the boat meets the water on an even keel. In order to break the fall of the craft and cushion its contact with the water, damper plates are carried by the bottom yoke on supporting rods.

DECEMBER, 1944





THE AMMUNITION IT SHOOTS!

BIG guns have a grim sort of glamour, but it's the stuff in the caissons behind them that hurts the enemy. It's the shell rather than the cannon, the torpedo rather than the submarine, and the bomb rather than the B-29 that obliterates him. Modern weapons can be no better than their ammunition.

American troops overseas now use up more ammunition in one day than the entire amount this country had before Pearl Harbor. Yet the United States now has so tremendous a supply that some plants producing ammunition have been diverted to other work. The quantity and the quality of American ammunition account for the superiority in firepower of the American forces.

Army and Navy ordnance experts have insisted on the biggest bombs and the fastest shells that can be used effectively. Thanks to improvements in measuring instruments and study of aerodynamic forces, American ammunition is better designed than Germany's and far ahead of Japan's. By systematic inspection of samples of each component, 99 percent of all defects have been eliminated, and the quality of America's quickly produced, better-designed ammunition has been rigidly maintained.

A basic component is smokeless powder to propel projectiles. It is generally made from cotton, although considerable powder

- And We're Shooting the Best

From land, sea, and air, we are hitting the enemy with the most destructive explosives ever known to the history of war.

By ARTHUR GRAHAME

is being made now from wood pulp. The cotton or pulp is impregnated with ether-alcohol to form a jellylike substance, which "macaroni" presses force through steel dies. It is extruded in single or multiple perforated strands of various diameters, which are then machine-cut into rod-shaped "grains."

This is tricky work that requires a lot of

WORLD WAR II HAS PRODUCED BOTH NEW AND IMPROVED WEAPONS



ARTILLERY has now reached an all-time high with mobile high-velocity guns throwing explosive shells capable of piercing even the heaviest armor

...

MECHANICAL FUSES, ingeniously made and far more accurate than powder-train type, have increased effectiveness of projectiles by detonating them with split-second precision



...



EXPLOSIVES, RDX, 20 percent more powerful than TNT, is giving Allied shells, mines, and bombs a wallop they never had before. Better powder also throws our shells

...

AIRBORNE CANNON make their debut in this war. They run from 20-mm. guns up to and beyond the 75-mm. slugger mounted in our B-25 Mitchell bomber



ROBOT BOMB, as yet unperfected, has nevertheless proved one of the most destructive war machines ever devised. Experts believe these jet-powered missiles capable of far greater range and accuracy



...



ROCKETS have made a big splash in the war scene, especially in the U. S. bazooka, now copied by other nations, and in plane-mounted rocket guns. It was rocket artillery that turned the tide at Stalingrad

...

MINES. These now include concrete-plastic antitank mines difficult to detect magnetic mines that move into the path of a ship and detonate by contact or remote control, and more deceptive "booby traps"



...



TORPEDOES are now launched from planes as well as surface and subsurface ships. A striking innovation in their use at sea is the one- and two-man torpedo

SHELLS AND RIFLE GRENADES ARE HURLED BY

TYPES OF LOADING



FIXED

Left to right: 57-mm. anti-tank; 75-mm. howitzer; 76-mm. chemical shell 3-inch anti-tank; 90-mm. anti-aircraft



SEMIFIXED

Disassembled 105-mm. shell. From left to right: fuse; high-explosive shell; powder bags; cut-away cartridge case with primer; and "booster" to detonate bursting charge



SEPARATE-LOADING

A complete 155-mm. howitzer round; (left to right) 96-pound shell, propellant, with igniter at breech end; container for charge

FUSES CAN BE SET TO DETONATE AT PRECISE MOMENT

HIGH-EXPLOSIVE SHELL AGAINST PERSONNEL IN THE OPEN



TIME FUSE FOR AIR BURST

QUICK FUSE FOR GRAZE BURST



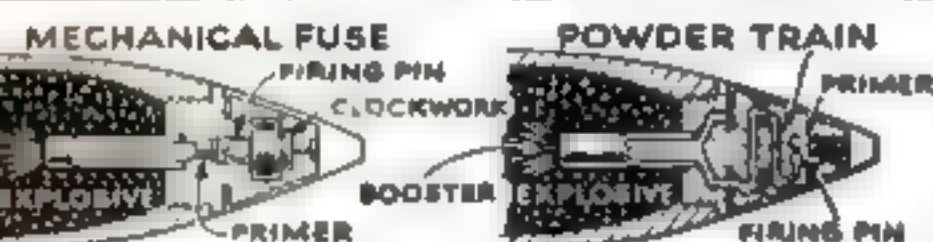
TIME FUSE FOR RICOCHET BURST

Fuses are three types: time, impact, and combination. Impact fuses are made superfast for adequate "frag" effect

HIGH-EXPLOSIVE SHELL AGAINST PERSONNEL WITH COVER, AND AGAINST FIELD WORKS

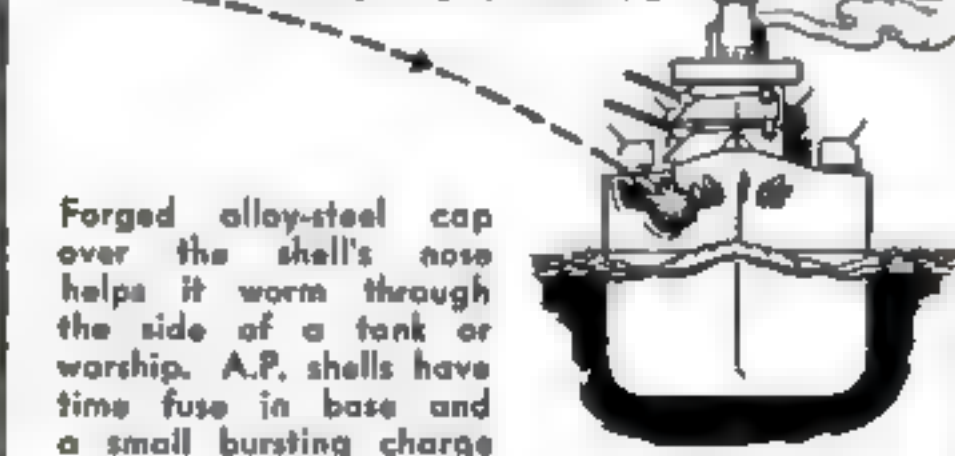


In bombarding comparatively unprotected personnel, shells need quick fuses for instant detonation. In shelling pillboxes or dugouts, however, projectiles carry time fuses which permit them to penetrate before they let go



Fuses may be of either the powder-train or mechanical type—the latter now having been developed to a high degree of precision. Each is illustrated above. Safety features of these fuses, as yet military secrets, have gone a long way toward preventing premature bursts in the gun, such as occurred in the first World War

ARMOR-PIERCING SHELL AGAINST ARMORED TARGETS



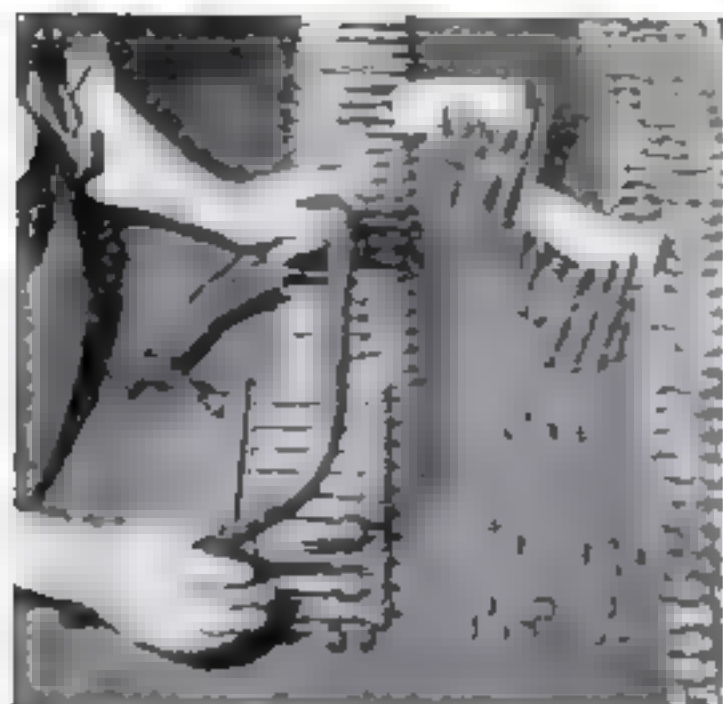
Forged alloy-steel cap over the shell's nose helps it worm through the side of a tank or warship. A.P. shells have time fuse in base and a small bursting charge

know-how. New and improved methods have greatly speeded up manufacturing. And the powder being made now is better than the powder used in World War I; it gives higher velocities, it is practically smokeless and flashless, and is more moisture-resistant. Hence, its performance is more nearly uni-

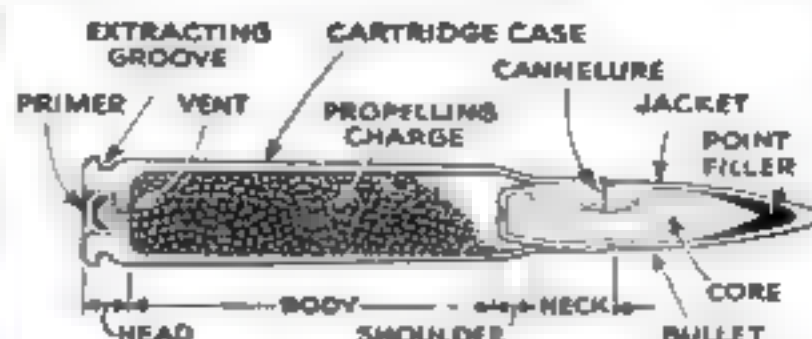
form through the wide range of climatic conditions that are encountered in global war.

High explosives, to give shells their destructive effect when they reach their destination, are another component of military ammunition. *(Continued on page 126)*

FORCE OF GAS EXPANDING IN A CLOSED TUBE

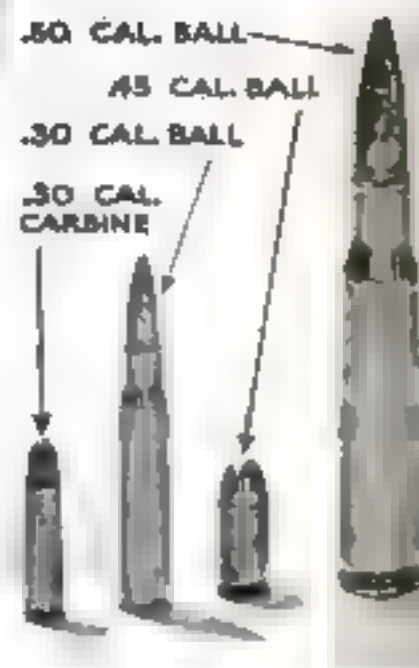


DISINTEGRATING LINKS are an improvement in feed belts for airplane machine guns. These light, tiny links bring the bullets to the firing chamber, then disengage to fall singly into a pile. Above, a hand press puts bullets into link chain

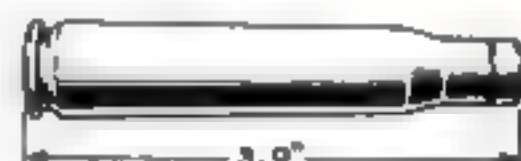


SECTION OF .50 CAL. BALL CARTRIDGE

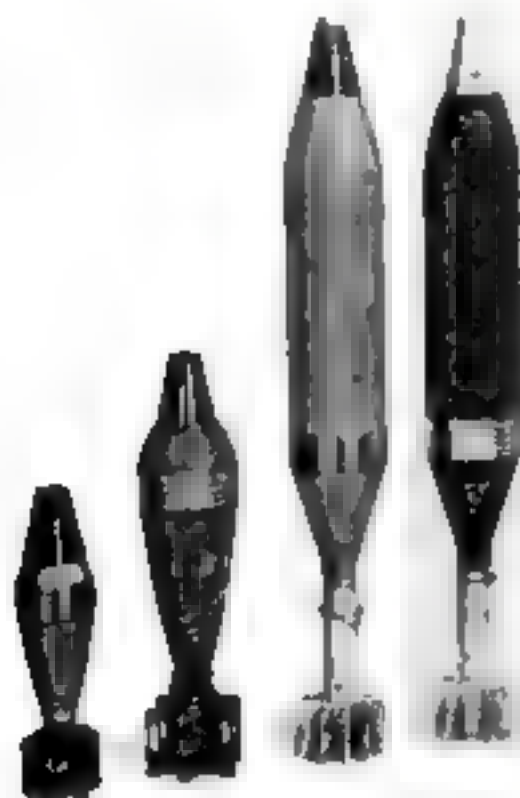
SMALL-ARMS AMMUNITION. Above diagram shows parts of cartridge such as at right and below. These are type of fixed ammunition, in which cartridge case is tightly crimped to shell. In semifixed ammunition, (see page opposite) case is loosely fitted, propellant can be adjusted to desired range



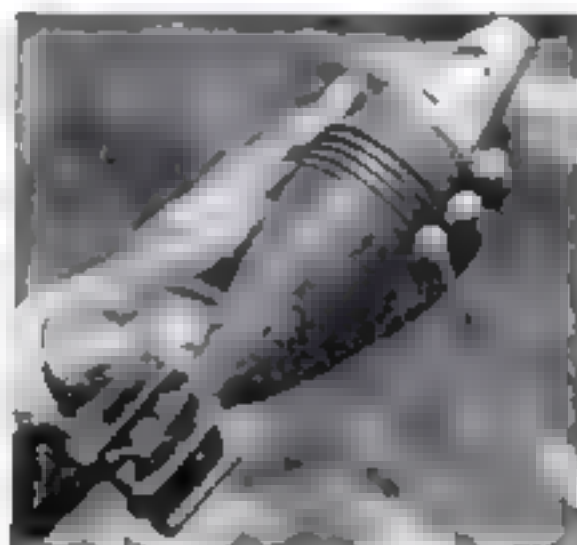
.50 CAL. ARMOR-PIERCING



.50 CAL. BLANK



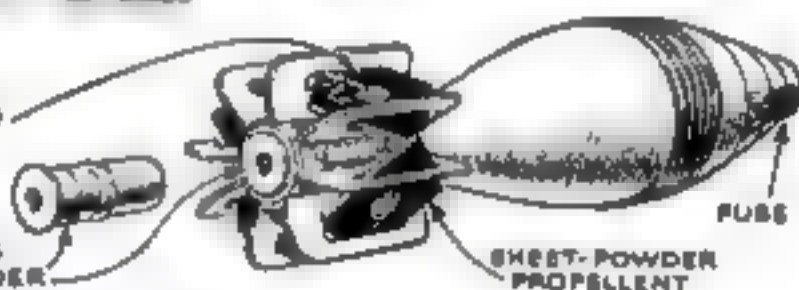
GRENADES. One of modern war's oldest weapons, the grenade was originally a hand-thrown projectile which, in its current form, could be tossed by the average soldier only 30 or 35 yards. In World War I its range was increased to 300 yards when armies began to launch their grenades from rifles. An improved launcher, designed for use on the Springfield rifle, is shown at right. Among the many types of hand grenades now in use are the fragmentation, smoke, and gas missiles shown at far right. A recent development is the concussion grenade, with an effective radius of only seven yards. This grenade has proved more suitable for hand-to-hand jungle fighting than the "frag" grenade, whose greater radius is often dangerous to the thrower



MORTAR SHELLS get extra boost from tiny sheets—having cellulose base fortified with nitroglycerin—that are placed in fins, as in mortar projectile at left. Propelling cartridge detonates the sheet powder. At far left: 3-pound shell for 60-mm. mortar; 7-pound high-explosive, 12-pound smoke, and 11-pound high-explosive shells, all designed for the 81-mm. mortar

PROPELLANT CHARGES IN FINS CAN BE REMOVED TO DECREASE RANGE

PRIMER SIMILAR TO A SHOTGUN SHELL ACTS AS PROPELLANT AND ALSO AS IGNITER FOR SHEET POWDER



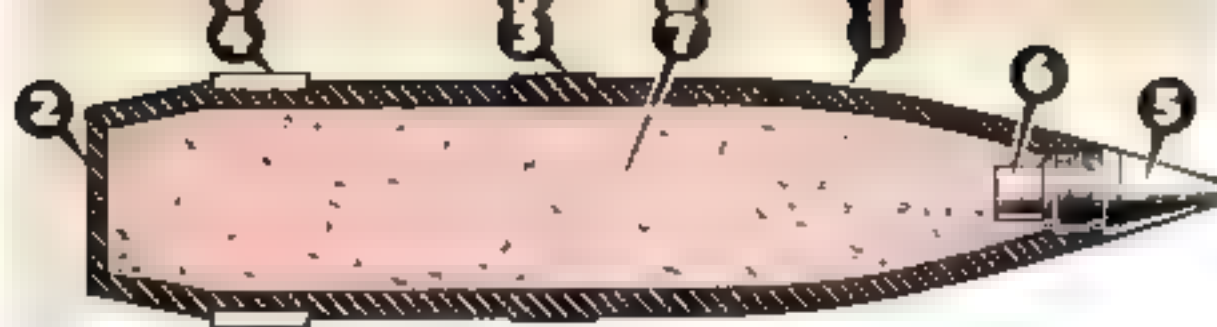
GRENADE, HAND, FRAGMENTATION, MK2



GRENADE, HAND, SMOKE, HC, MB



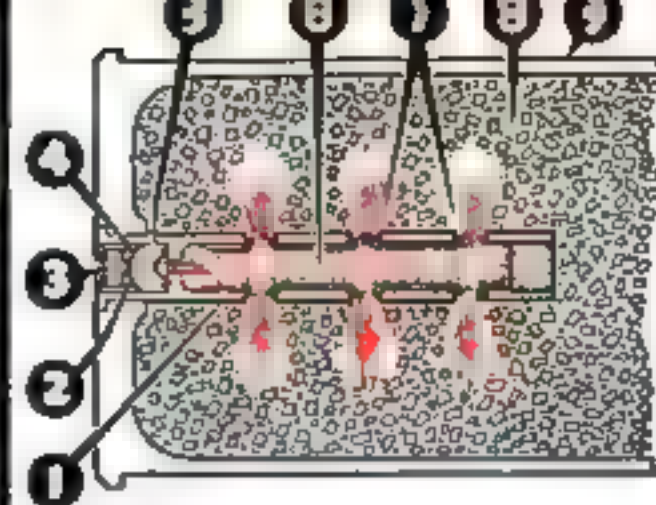
GRENADE, HAND, GAS, IRRITANT, CN, DM, MG



HIGH-EXPLOSIVE SHELL is made up of (1) a steel case, (2) base cover that is welded, (3) bourrelet, (4) rotating band, (5) detonating fuse which operates on impact, (6) booster charge of tetryl. This charge, set off by the fuse, in turn sets off the main bursting charge (7) consisting of TNT, amatol, or the new powerful RDX.



IN THE GUN, the only parts of the shell that touch the barrel are the rotating band and bourrelet. As the propellant pushes the shell forward, the rifling bites into the band, thus causing shell to rotate. The bourrelet, a bit larger than the body of the shell, bears on the gun's lands to keep the shell away from barrel's walls.



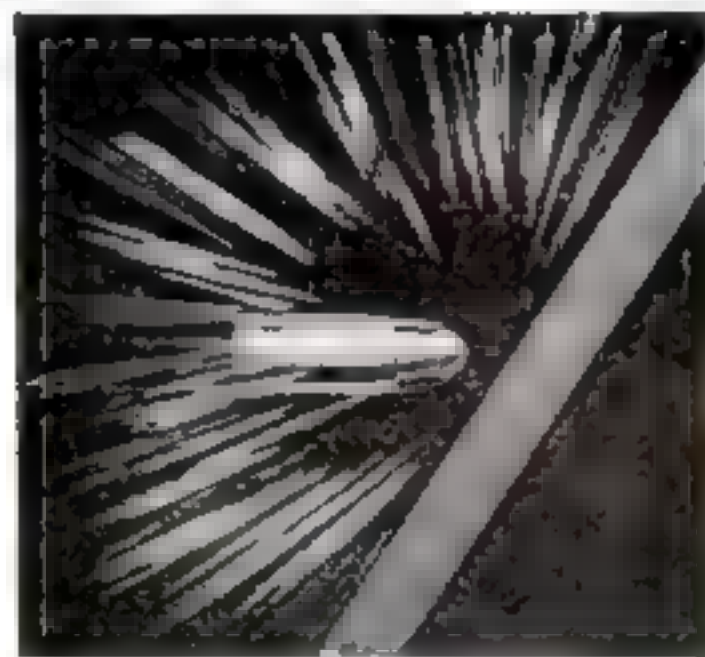
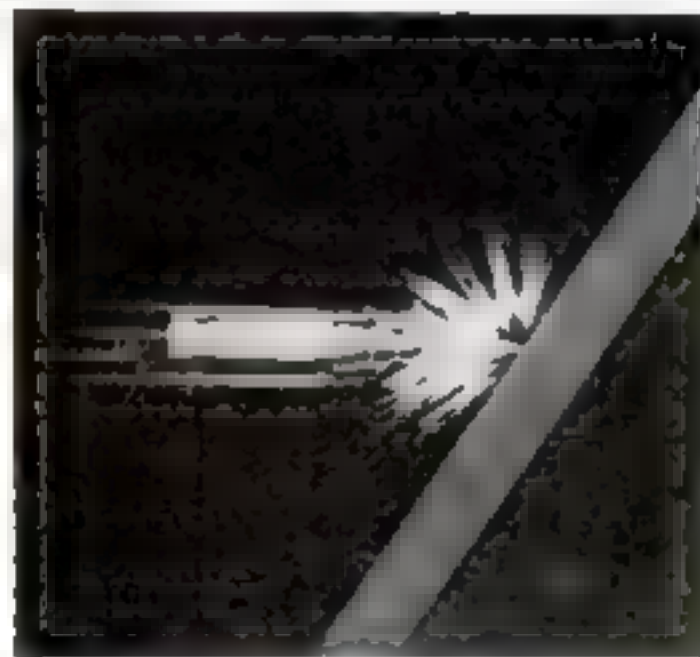
THE CARTRIDGE that hurls the shell is composed of (1) primer, (2) primer cup, (3) firing plug, (4) percussion charge of mercury fulminate or similar explosive, (5) anvil, (6) igniting charge of black powder in paper tube, (7) holes in primer, (8) smokeless powder, (9) cartridge case.

TNT, one of the most powerful explosives in common use, is used in shells, bombs, torpedoes, depth charges, and mines. It is made by nitration of toluene—which is obtained by cracking petroleum and from by-product coke ovens—with nitric and sulphuric acids. Amatol, which is sometimes substituted for TNT in shells and is used

more frequently in large aircraft bombs, is a mixture of TNT and ammonium nitrate. It is almost as powerful as TNT.

RDX is a new explosive, the prime ingredient of which is an unstable chemical combination of ammonia and formaldehyde. In aerial bombs it has been found to be 20 percent more violent than TNT. Pentolite,

HOW ARMOR-PIERCING SHOT PENETRATES



1 A sharp aluminum cone of extreme tip streamer shot as it speeds toward the target.
Photographs from General Motors

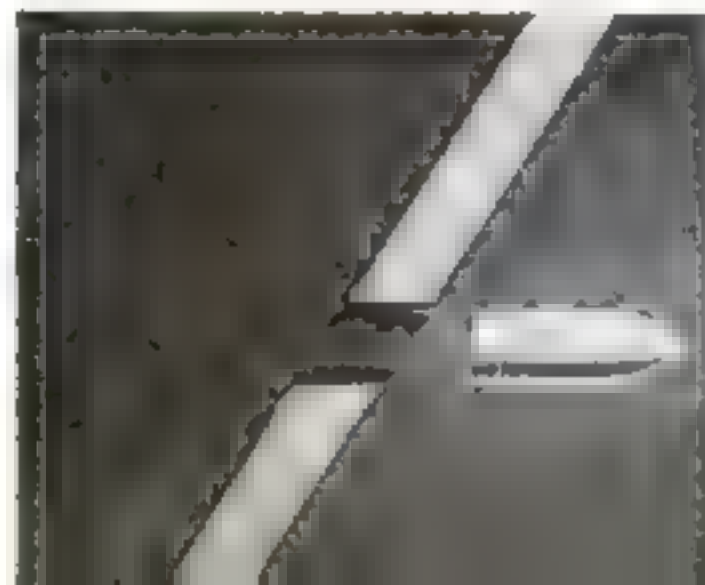
2 On impact, aluminum cone, which has served as a "windshield," shatters, leaving shot only with steel cap nose.

3 The steel cap, the equivalent in toughness of a hard piece of boiler plate, now spearheads shot.

4 Tough steel nose cracks into armor plate, weakens it.

5 Here the shot begins its penetration of the softened-up armor spot.

6 As it cracks through the armor, shot loses its steel-cap nose.



a new explosive used in rocket projectiles, rifle grenades, and some types of artillery shells, is also 20 percent more powerful than TNT. Another new American superexplosive is haleite, named for Dr. G. C. Hale, of Picatinny Arsenal.

Ammonium picrate, which is known as Explosive D, is less powerful than TNT, but is used as the bursting charge in armor-piercing shells because it is not affected by external shock and does not explode until detonated by the action of a fuse and booster charge after penetration. It is made from phenol or by neutralizing picric acid—derived from benzene obtained from by-product coke ovens or from petroleum—with ammonia.

For the fast-firing weapons that have raised battle expenditures of ammunition to fantastic heights, American plants have produced about 25,000,000,000 rounds of small-arms ammunition since the war began and are continuing to turn out more than 500 cartridges a second, 24 hours a day. Making and assembling the components of .30, .45, and .50 caliber small-arms ammunition used by both the Army and the Navy is a complicated process, requiring more than 200 operations, but highly mechanized production lines have made this huge output possible.

One of our outstanding ammunition successes has been a .50 caliber incendiary bullet. Mixed with armor-piercing cartridges in machine-gun feed belts, it penetrates self-sealing gasoline tanks and, in exploding, generates intense heat which ignites the fuel and destroys the plane. This bullet has undoubtedly helped to shorten the war.

Shells commonly used by Army artillery and Navy ships' guns are of three types:

The high-explosive shell (called "high-capacity" shell in the Navy) contains a relatively large bursting charge of TNT, which is detonated by a fuse in the nose of the shell. Projectiles of this type are used for their blast effect against unarmored targets and for their fragmentation effect against personnel—the 1½-pound bursting

charge in a 10-pound 75-millimeter shell shatters it into some 400 jagged pieces of steel.

The armor-piercing shell contains a relatively small bursting charge of ammonium picrate, which is detonated after penetration by a fuse in its steel base plug. The projectile is shorter and heavier than a H.E. shell. An armor-piercing cap of forged alloy steel is fitted over its nose and over this is placed a hollow steel or aluminum windshield which improves its ballistic qualities.

The chemical shell, used principally by the Army, is similar to the H.E. shell in design and construction, but is filled with a smoke-producing or incendiary composition instead of TNT. Chemical shells and bombs are loaded by the Chemical Warfare Service.

The primer is the spark plug of the propelling charge. In a small-arms cartridge it is a tiny copper cup containing mercury fulminate which explodes when it is struck

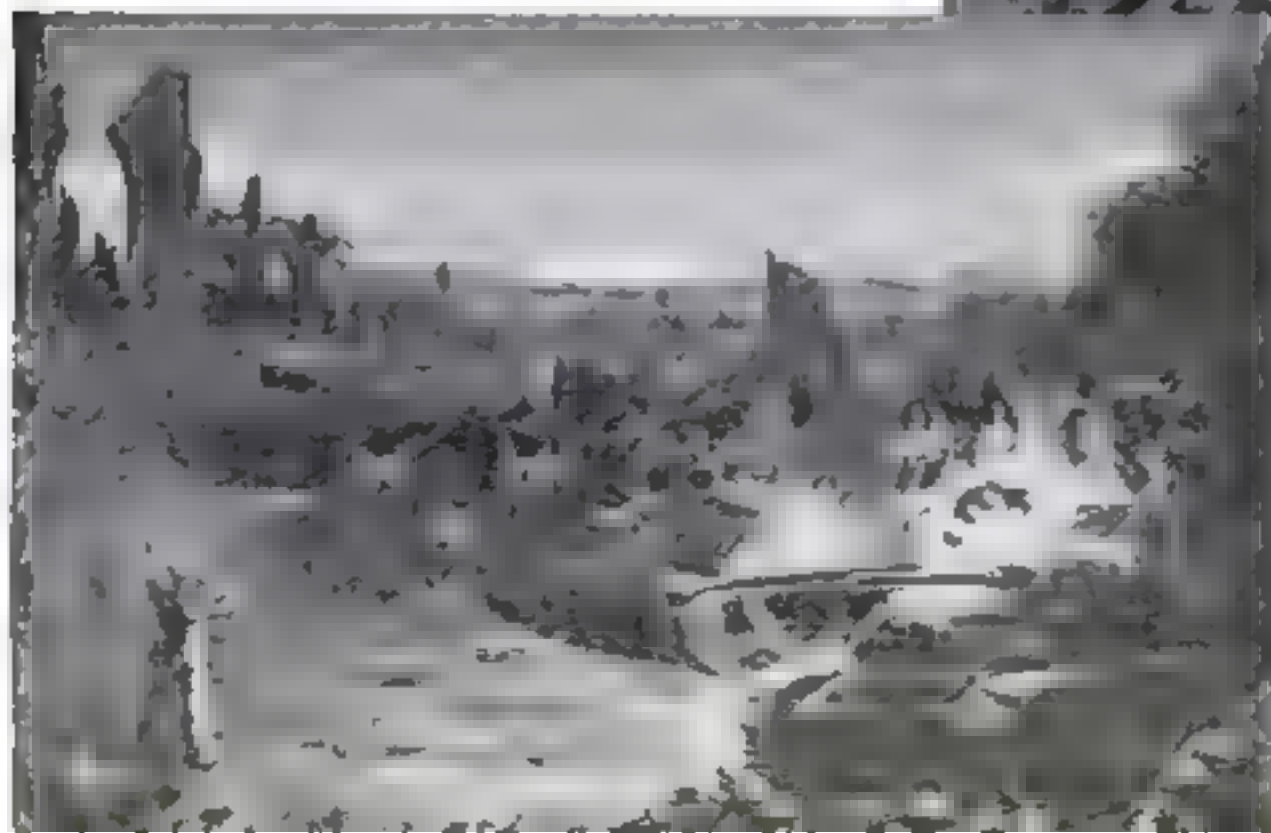
SHELLS ALSO DO ODD JOBS



Leaflets for warning civilians to leave a section about to be bombarded by Yank forces are put into 155-mm. shells, which are then shot into the area. A small charge is used to scatter the papers about

Converging streams of tracer shells serve as guides to Allied forces making a night attack on an enemy position

Reproduced from THE SPHERE





GERMAN 21-CM ROCKET, cut away to show interior design. Propellant charge is in place, at left. Empty nose carries 224 pounds of TNT. A rocket of this type makes shrill, piercing noise as it speeds through the air has been nicknamed 'Screaming Mimi' by our GIs

NOZZLE OPENINGS in rear of rocket at left are offset at 16-degree angle from longitudinal axis of rocket to give the projectile a rotation similar to that of a shell. Rocket is used mainly against personnel

PRESENT CONFLICT EMPLOYS GREATEST VARIETY OF AMMUNITION



by the firing pin and shoots a flame into the cartridge case to ignite the propelling powder. The much larger quantity of smokeless powder in artillery ammunition requires more flame to ignite all of it instantaneously, and this is supplied by a black-powder igniter which is fired by the primer and in turn fires the propelling powder. In fixed and semifixed ammunition, the igniter powder is contained in a perforated metal tube attached to the inner side of the base of the cartridge case. In separate-loading ammunition it is packed in a red bag attached to the breech end of the propelling charge, and is ignited by a percussion or electric primer inserted in the gun's breechblock. The difference between fixed and semifixed ammunition—each round of which is loaded into the gun as a complete unit—is that in the first the

ROCKETS OF THE PAST



CONGREVE ROCKET, developed in early 19th century, had an explosive in its head, was fired from a tripod-mounted tube fitted with tangent sights. It was only moderately successful

HALE ROCKET superseded the Congreve, was built in nine and 24-pound sizes, and designed for field and fortress warfare. It was fitted with a screwlike tail in an endeavor to give it a truer flight



KNOWN TO WARFARE

BOMBS used by aircraft can be carried to, and aimed at, the target. But, once released, they can no longer be directionally controlled



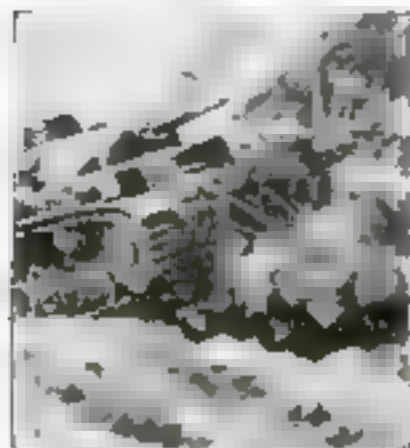
ROCKETS have the advantage of being powerful weapons that are light enough to be mounted in numbers on a plane. Like fixed guns, however, they can be aimed only by aiming the ship



MINES have to wait for a target to come to them. Their advantage is that they can be big enough to do a lot of damage once it arrives. Land mine usually operates by contact; sea mine by contact or remote control



TORPEDOES can be preset to follow any desired course, or guided by remote control, after being fired. They can be launched from planes, surface craft, or submarines



Drawings by B. G. Serfaty

cartridge case is tightly crimped to the shell, while in the second the case is loosely fitted and the propellant charge can be adjusted to the desired range.

After projectiles leave the gun barrel, their functioning is controlled by ingenious and complicated fuses that are set to explode the bursting charge at the instant when it will do the most damage.

Dazed German prisoners captured in the European theater mutter, "Zauberfeuer!"—"magic fire!"—when questioned about the effectiveness of our artillery. This red magic is attributable largely to our fuses.

Our use of French 75-millimeter guns and ammunition in World War I was marked by numerous tragic premature shell bursts in the gun barrel because of the crude fuses. Twenty years of between-wars work at the Ordnance Research Center at Aberdeen Proving Ground enabled us to enter this war with a complete line of artillery fuses which can be used in guns of any caliber. They have many secret features, among which are multiple safety devices—no one of which is solely depended on to make them safe while they are in the gun barrel. Their use has practically eliminated premature shell bursts in the barrel.

Our fuses are of three principal types—impact, time, and combination.

Impact fuses, which function on impact with the target, are of three varieties. Supersensitive fuses are used in the H.E. projectiles of the lighter antiaircraft guns, and function on contact even with the fabric of a plane in flight. (Continued on page 130)



Like swallows heading south, rockets from U. S. warships head for the Jap-held island of Peleliu as a prelude to a Marine invasion. Smoke shows previous rockets have landed and have situation well in hand



MAGNETIC ANTITANK MINE, used by the Nazis primarily to destroy their tanks to prevent their being captured intact, also can be used offensively. Tested on piece of mild steel (below) $6\frac{1}{4}$ inches in diameter, the mine blew a hole almost the entire seven-inch length of the billet



MINE IS APPLIED by hand to side or bottom of tank and held there by three magnets. A time fuse enables the placer to escape before the blast occurs

Superquick fuses are used when an instantaneous burst on contact is wanted for blast or fragmentation effect. Delay fuses are used when some degree of penetration before the burst is desired, and for ricochet bursts.

Time fuses are actuated either by a watchlike mechanism or by a compressed black-pow-

der train, and are set to function at a predetermined time after the instant of firing. The use of mechanical time fuses in large-caliber H. E. shells to obtain overhead bursts—something new in warfare—has proved very successful in our European campaigns.

Combination fuses have both impact and time mechanisms.

Impact and combination fuses usually are placed in the nose of the projectile; time fuses usually in its base. Whatever its type, the fuse detonates a booster charge—usually of tetryl, a sensitive explosive derived from benzene—which in turn detonates the bursting charge.

Considerable handwork still is necessary in

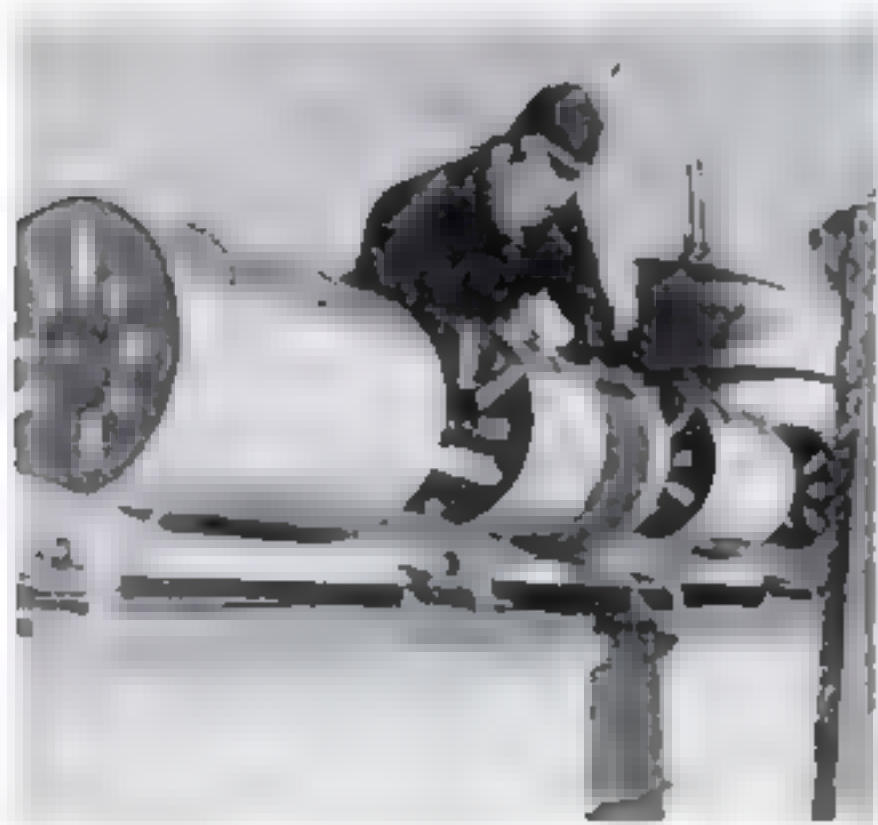
fuse making, although the use of recently designed machines has increased output.

Shell production has been speeded up tremendously by the use of hydraulic and mechanical drawing presses for forging the bodies of small and medium-caliber shells. So accurate is this work that little or no internal finishing is required and only a minimum of material is left to be removed by

shell-turning lathes. The rotating band and the bourrelet, the only parts of the projectile that touch the gun barrel, are machined to extremely close tolerances; the body of the shell is machined to a slightly smaller diameter than the bourrelet.

Before Pearl Harbor, all our small-arms and artillery cartridge cases were made of brass. When a *(Continued on page 209)*

NAZI SUB MENACE ENDED UP IN NAVY'S "ASHCANS"

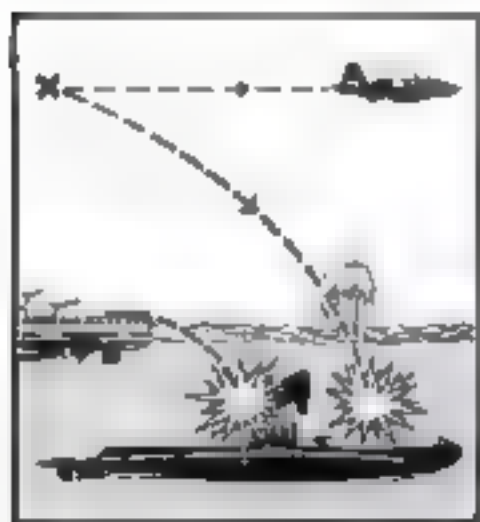


U. S. depth bombs have a bursting charge of TNT, come in 325- and 650-pound sizes, and have a fuse that can be set to detonate at any desired depth



Official U. S. Navy photos

Depending on position of the sub, the charges are either rolled off back end of fast-moving destroyer or tossed to either side from a "Y" or "K" gun



Charges can also be dropped from a plane, which often finds it easy to spot a sub that isn't very deep and is moving through clear water

As suggested by this mountain of spray, the charges pack a terrific wallop. In some instances, instead of springing a sub's plates while it is submerged, the charges will blow a sub to the surface to make it an easy target for shellfire



"I Scored Exactly 100 This Afternoon"

BOASTED a GI who had made his own target. "How come?" his buddies asked. "That's for you to discover," the GI challenged. So one of the boys made a study of the figures shown on the target rings and doped out the answer.



Now You Try!

Reproduced from "At Ease!"
by Jules Leopold, published
by Whittlesey House, New
York, N. Y.



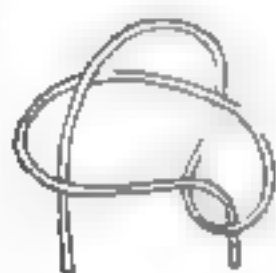
EVERY one of these puzzlers
is a challenge to your in-
genuity. You'll find the solutions
on page 210.

BONG

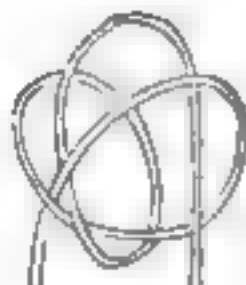


That old grandfather clock in the hallway
bongs out five o'clock in five seconds.
How long will 10 bongs take? Steady,
now! Take your time!

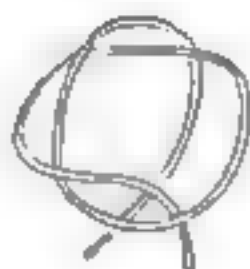
Private Dugan is skillful at pitching pennies;
lays 'em down in one row of four, another of
three. He bets that merely by moving one coin
he can make two rows of four pennies each.



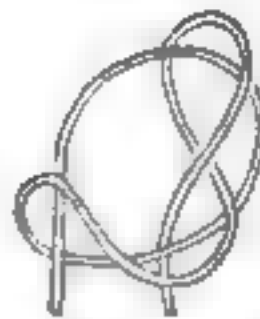
1 _____



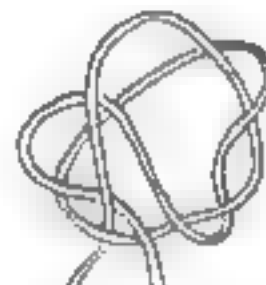
2 _____



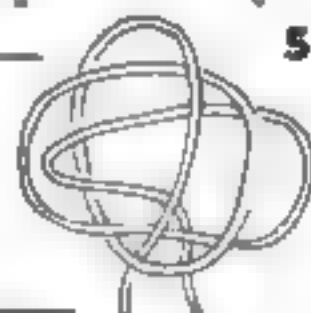
3 _____



4 _____

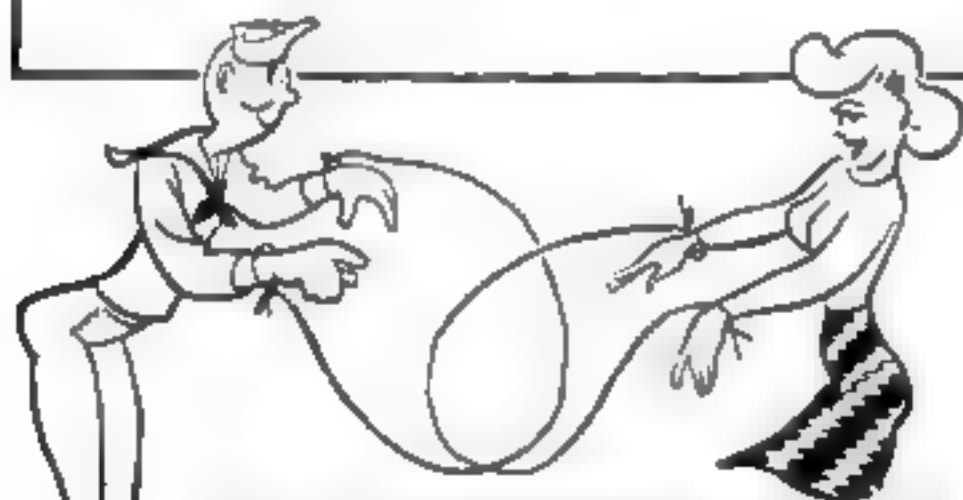


5 _____



6 _____

Here are six rope tangles. Imagine that you are pulling
the two ends of each in succession. Which would form
a true knot and which would pull out straight without any
knot? Below each write either *Knot* or *Nix*, and then
check with the answers.



The ends of a piece of string are tied to the
galler's wrists. A similar string is looped
through and tied to the girl's wrists. Question
is: Can these two people get loose—if they
want to—without breaking or untying string?



Rearrange these coins moving one quarter
into the middle and observing that: Left
quarter may be moved but not touched;
right quarter may be moved and touched;
nickel may be touched, but not moved.

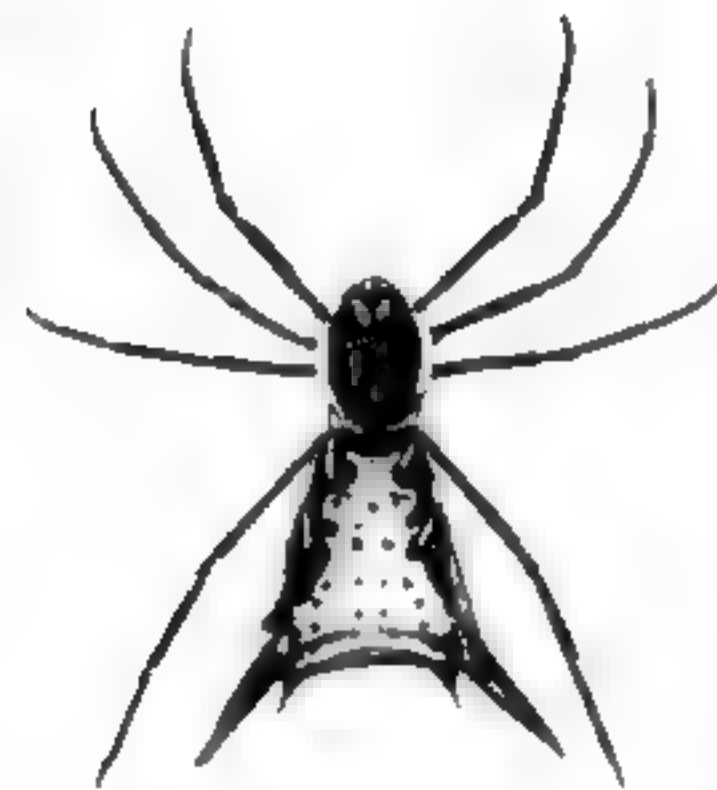
FOR CORRECT ANSWERS TURN TO PAGE 210

Painting with the Microscope

UNFAMILIAR realms of nature are being revealed by Artist George Alan Swanson, of New York, who paints detailed portraits of strange, infinitesimal creatures with the aid of a microscope. In dank and steaming jungles, as well as fathoms deep in the ocean, he collects specimens and data relating to his subjects. When he returns, he is all set to bring his artistic and scientific ability into play.



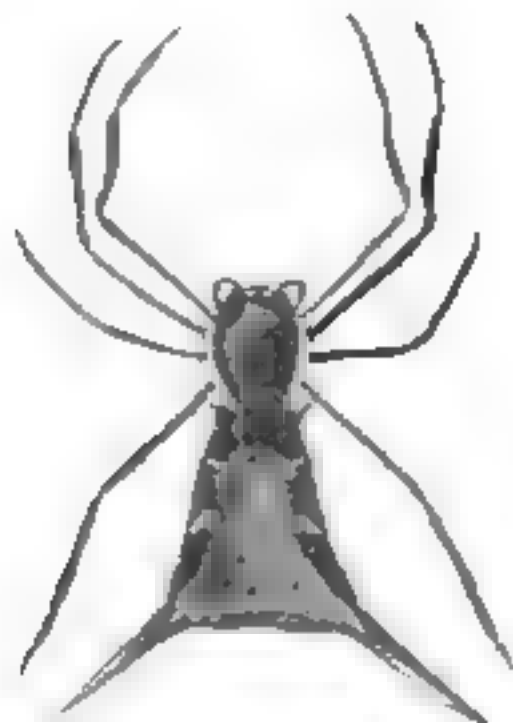
Enlarging it to dimensions easily comprehended by humans, George Alan Swanson, microscope artist, painted this picture of a leaf hopper



With his eyes to the microscope, the artist is drawing (right) a picture of a tiny spider to illustrate a treatise for a zoological organization



Colorful details of tropical jungle spiders (left) can be accurately reproduced only after most careful observation with the microscope. Spectacular hues of red, yellow, and orange are revealed



Right: a thrill for an oculist—a much enlarged drawing by Mr. Swanson of the almost invisible eye of a tropical fly



Robot Navigator Rides the Jeep

SECRETLY DEVELOPED, THE
ODOGRAPH MAKES THE TINY
QUARTER-TON A SURVEYOR



Feeling its way through the darkness with the magic aid of the odograph, a jeep leads tanks to launch on attack

IN THE back seat of a jeep the Army has put a brass brain to note how far and which way the jeep goes. By recording the car's course on a sheet of paper, it not only provides proof of where GI's have gone, but also keeps men from getting lost and enables them to locate and liquidate the enemy quicker.

Given a map and this mechanical checker-upper, known as an odograph, an armored column can be led through smoke, fog, or pitch darkness as swiftly and certainly as though every landmark and guidepost were visible.

With an odograph, a scout can map unfamiliar territory in a jiffy, by simply driving over it. The line traced by the pencil

By **VOLTA TORREY**

Photographs by William W. Morris

of the odograph will show the direction and distance he travels, thereby producing a map for others to follow.

The position of an artillery observer who dashes out in an odograph-equipped jeep need not be painstakingly determined with surveying instruments before the big guns are fired. The device in the back seat will show exactly where the observer is the instant he hops out of the car.

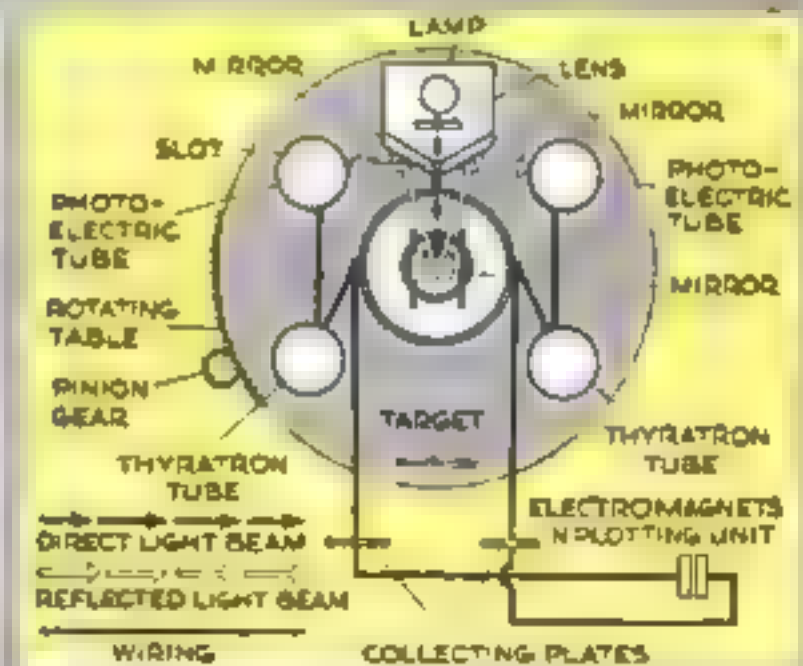
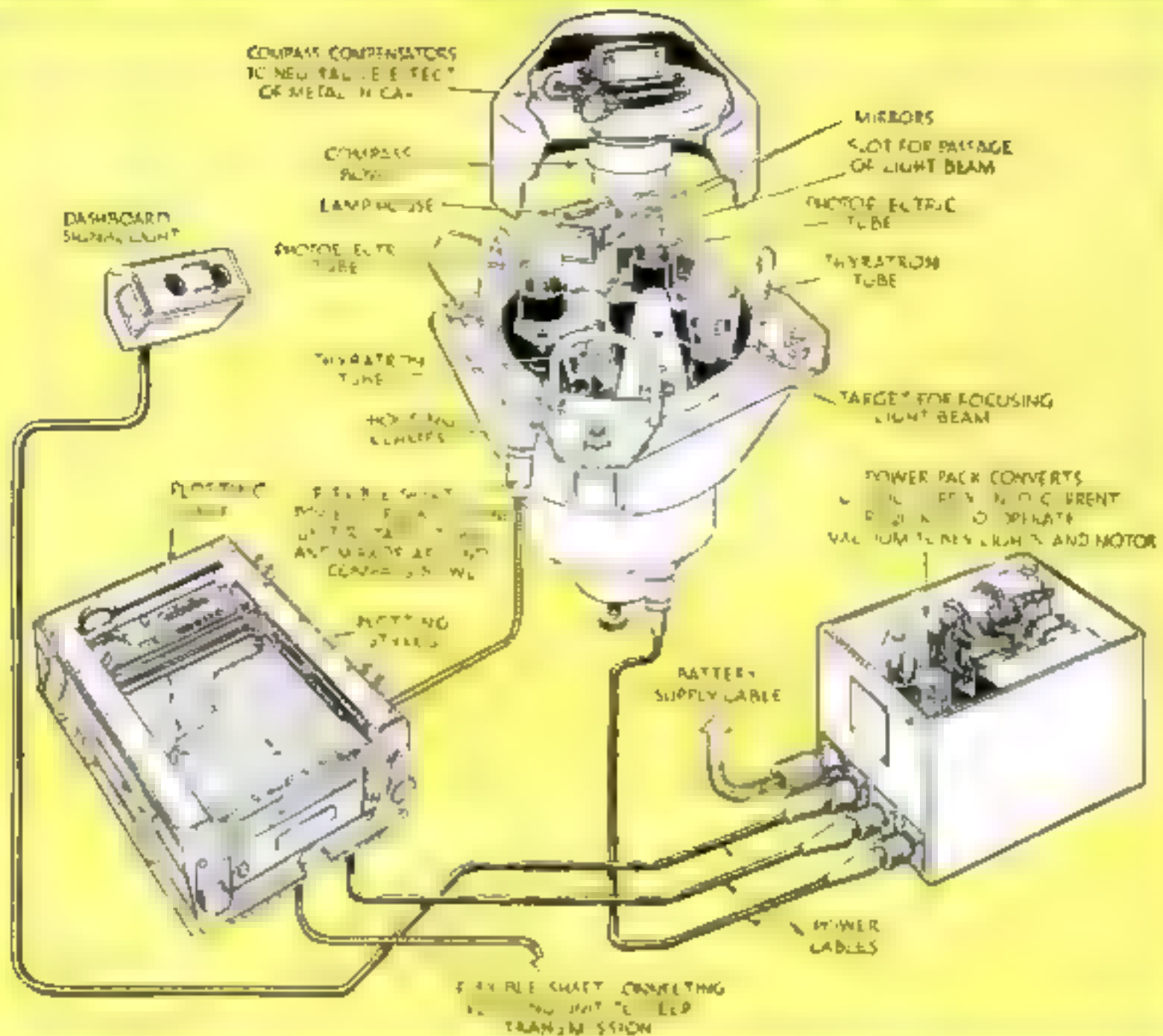
Thus, odographs are not merely a means of keeping confused men from running around in circles, but also a means of training mighty weapons on the target more suddenly. The odograph, in fact, is so helpful in combat that when Lt. Gen. George S. Patton saw one of the early models tested at the Desert Training School, he declared: "When I go into action, I want one of those machines, even if I have to take a company of mechanics along to keep it in running order."

The odograph is one of the most complex of modern military instruments, but has been so perfected that GI's have learned to handle it in a couple of weeks. Several hundred of these mechanical draftsmen have been built and used to supply field commanders with essential maps much faster than such maps could be drawn by human experts. Standard producer of the odograph is the Monroe Calculating Machine Company, Orange, N. J.

This lightning cartographer is a 200-pound maze of mechanical and electronic apparatus, difficult to duplicate without a model. Hence, until recently, the odograph was one of America's most carefully guarded war secrets. The idea came from the Engineer Board, the research organization of the Corps of Engineers. Civilian scientists and engineers helped develop the idea in locked laboratories. Only a few key employees of the two computing-machine companies that have manufactured odographs were told what use would be made of the various parts, and soldiers were instructed to destroy the instruments rather than let them be captured. But now this remarkable invention can be described.

It has four parts: a power pack, a dash-

THESE MAIN PARTS MAKE AN ODOGRAPH INSTALLATION



Odograph mounted in a jeep. Drawing shows how vacuum tubes in compass unit detect changes of course

HOW IT WORKS. When the jeep changes direction mirrors mounted on the compass card (see drawing of top) reflect a beam of light as the card swings to and fro in the suspended bowl. The reflected light energizes one of two photoelectric tubes paired with thyatron tubes, which control the flow of current to turn the compass table accordingly. This motion is transmitted to the plotting unit, where a stylus records the change of direction on the map. At the same time, the plotting unit is informed mechanically as to the jeep's speed, by means of a flexible shaft from a speedometer drive in the car's transmission. These data, combining direction and distance, are co-ordinated by the plotting unit and recorded on a sheet of graph paper by the stylus, a pencil held above the paper by two arms. One arm moves back and forth across the paper the other up and down. These arms move the pencil to trace a line on the paper corresponding to the course of the jeep, whether it is slowly zigzagging through a forest or racing down a straight highway at 60 miles an hour. A dial alongside the paper shows the direction in which the jeep is headed, and counters indicate the number of miles it has come north or south, and east or west, since leaving its starting point



IN DARKNESS, SMOKE, OR FOG: A jeep equipped with the odograph can follow a course on a map

board indicator, a compass, and a plotting unit. These parts are connected by electric cables and flexible shafts. The power pack simply steps up the current from the jeep's battery to the required voltage. The dashboard indicator merely warns the driver of the jeep when the odograph has stopped, or it is time for him either to change his course or put a fresh sheet of paper in the plotting unit. The compass and the plotting unit are the intricate parts.

Compensating magnets neutralize the effect on the compass of the metal in the vehicle. Two mirrors on the compass card reflect a beam of light as the compass swings to and fro. This reflected light en-

ergizes one or the other of two photoelectric tubes. These are paired with thyatron tubes, which control the flow of current from the power pack to the plotting unit to inform the latter of the direction.

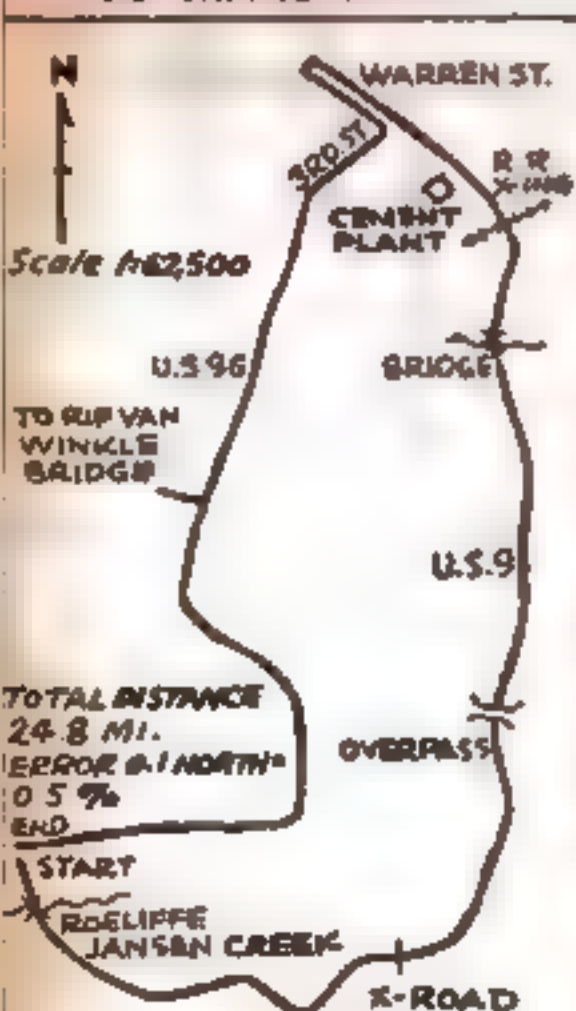
The plotting unit is a metal box, about the size of a portable-typewriter case, and well filled with shafts, gears, magnets, and a motor. On its upper surface, protected from moisture and dust by a glass cover, is the plotting paper. An 8½ by 11-inch sheet, the size of ordinary typewriting paper, is used; it is divided by lightly printed lines into one-inch and 1/10-inch squares. Fresh graph paper can be run in when necessary by turning a roller. Shaded lights illuminate the top of the plotting unit, and the driver, by glancing over his shoulder, may see instantly both where he is and how he got there.

To make a map, the odograph operator need only place a sheet or roll of the ruled paper in the plotting machine and select a scale by turning a knob. He may let a mile be represented on his map by any distance from an eighth of an inch to three inches. Thus, by varying the scale, he may record his course over any area from about nine to 6,000 square miles on a single sheet of paper. If he wishes to show the location of bridges, railroads, or other topographical features, he may mark them in on the paper in the plotting machine without interfering with the mechanism.

Maps made this way are accurate enough for most military purposes. Allowances must be made for hills or other irregularities, because the machine records the

THREE WAYS THE ROBOT NAVIGATOR IS USED AT THE FRONT

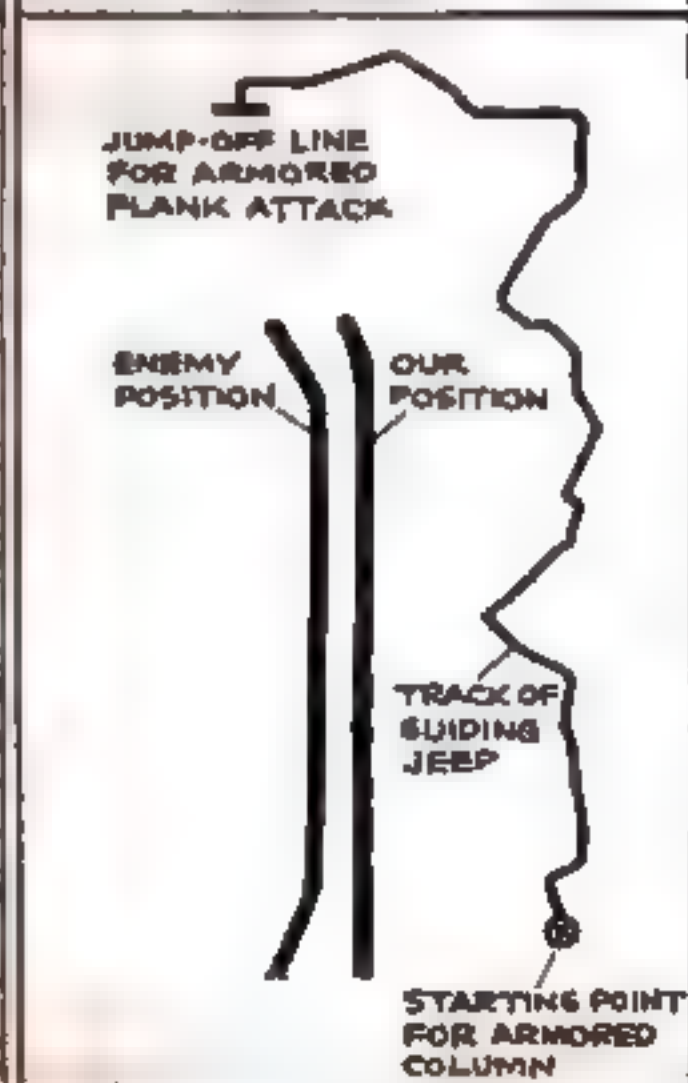
TO MAKE MAPS



TO FOLLOW MAPS



TO LEAD



FOR POPULAR SCIENCE READERS, an Army jeep made a trial run over highways near Washington, D. C., to show how the edograph would record the journey.



Start of the trip.
The other photographs show the jeep passing the various landmarks noted on the map made by odograph

actual distance traveled by the vehicle rather than air-line distances. Slight errors may be caused, too, by the wheels slipping or spinning. But under average conditions, the map drawn by the odograph will not be off more than a mile for every 50 or 100 miles traveled on roads, or a mile for every 35 to 75 miles covered across country.

When an accurate map is already available and is to be followed, it may be placed in the machine, and the line drawn by the odograph's pencil will show the progress

and position of the jeep on that map at all times. This facilitates detouring around enemy obstructions without getting lost.

The odograph can be used for all sorts of exploring after the war. Great areas of the earth remain to be mapped, and this can be done more quickly, thanks to this invention. The odograph may also provide a guarantee that forests, ranches, oil fields, and highways have been properly patrolled. It may even interfere with the pleasures of traveling salesmen.

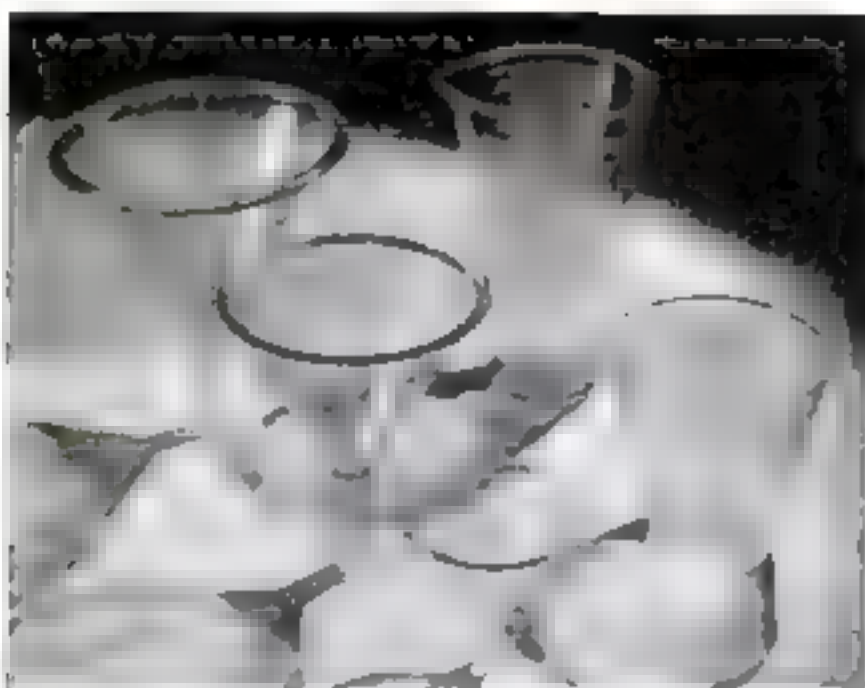




Moving a bottle up and down in ice and salt in this device cools its contents. At right, laboratory flasks for a kitchen



FAST-WORKING COOLERS, heat-proof laboratory flasks, and a new type of pitcher with two pouring spouts are among postwar household utensils recently exhibited at the Museum of Modern Art in New York. A dozen ice cubes and a little salt in the device shown at left cool the contents of a bottle in 10 minutes. Moving the bottle up and down in the container circulates brine. The flasks (left below) can be used both on the kitchen stove and for serving, while the spherical pitchers directly below feature a long spout that can be held as a handle when the other opening is used for pouring



PLASTIC FUNNELS, graduates, and measuring cups on the market are made of transparent, nonshatterable Lumarith with markings molded in them. They are a product of B & W Molded Plastics, of Pasadena.

NEW ELECTRIC IRONS, with some changes in external finish but otherwise similar to the last prewar models, are being made under sanction of the OPA and WPB. The iron shown below is being produced at the Ontario, Calif., plant of the General Electric Company. It is automatic.

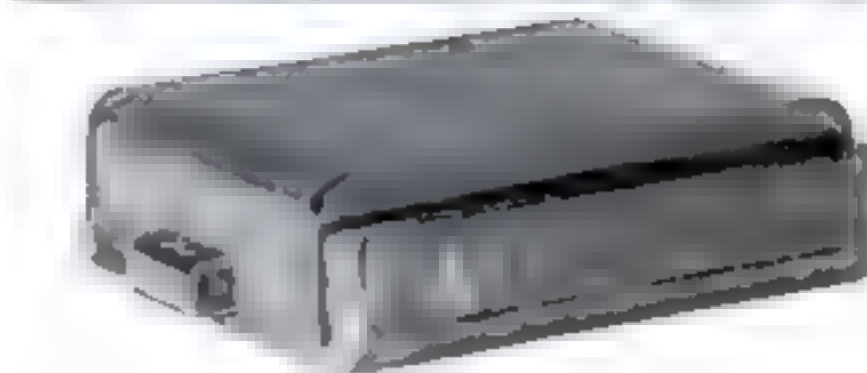


What's New in Modern Living

ODDS AND ENDS OF SOAP put inside this cellulose sponge can be used in car and upholstery cleaning, dish and window washing, and other housework. The sponge is made by Trindi Products, Ltd., of Chicago.



FOOD KEEPS FRESHER and refrigerator odors are counteracted with the use of a pint of white vinegar poured over a humidifier. This is a block of porous material that is kept in a dish on one of the shelves. The unit, made by Atmos Products Co., of New York, is indicated by a white arrow below.



FIVE MINIATURE PHOTOS can be framed in this Lucite case that folds to $\frac{1}{2}$ " by $\frac{1}{2}$ " by 2" for tucking into a purse or pocket. The cases, in colors or leather covered, are made by Stylor, Inc., of New York.

CHILDREN'S ROCKING CHAIRS are made and upholstered to duplicate similar chairs used by adults. Below, some of the rockers are shown being arranged by Aviation Cadet Dave Staudt at his parents' plant, the Staudt's Child Rockers, of New York.



Gus Licks a Cold-



By MARTIN BUNN

THE red thread of mercury in the thermometer outside the Model Garage was pressing 20, and passing citizens were hurrying along with heads bowed to the icy blast of a north wind, their overcoat collars turned up around their ears.

Joe Clark, gazing out of the window of the snug office, grinned widely. "Cold morning," he remarked. "Bet a lot of people are walking who didn't expect to."

Gus Wilson looked up from some time and material slips he was working on. "Stop gloating over the discomforts and misfortunes of your fellow man," he said.

"I'm not gloating," Joe replied. "But I could be. The first real cold morning always brings a lot of business, and—" A peremptory ring of the phone cut him short.

"There you go," Joe commented and picked up the receiver. "Model Garage," he said, and then, with a wry face, he listened for maybe three minutes. "Yes," he finally put in. "All right . . . Of course . . . As soon as we possibly can. Good-by."

"That was Mrs. Miller," he told Gus. "Talked so fast I couldn't get a word in. She says—"

Gus laughed. "You don't have to tell me what she says—I know. She says her radiator's frozen. I knew that without her calling. I've been keeping her last year's anti-freeze for her. Three weeks ago I told her she'd better let me put it in, but she was in a hurry. When it began to get cold yesterday, I phoned her, and she said she'd

come right over. But she didn't. I'll send Stan over to thaw her bus out."

"I told her we would," Joe agreed. "That was the first call for help, but it won't be the last . . . Doc Nicholson just got off the bus, and he's heading this way."

Gus grunted and went into the shop. For a couple of minutes he heard a rumble of voices in the office, and then Dr. Nicholson came out into the shop. He's the new principal of our high school—he took Professor Hiram Scruggs's job a year or so ago when that old crab retired and moved away. Doc's a stout, red-faced, hearty man, as jolly and popular as Scruggs was cross and disliked.

"Morning, Gus," he called out in his usual breezy style. "In me you see a man who is disillusioned, perplexed, and in dire need of a friendly helping hand."

Gus grinned. "Meaning that you couldn't get your car started?" he asked.

"Meaning just that," Nicholson confided. "And what a blow it was. When I saw what sort of day we were having, I said to Mrs. Nicholson: 'This is a morning when one really appreciates having a car—even if one does have to pick up three talkative schoolmarmas on the way.'"

"Full of confidence engendered by the fact that a month ago you had serviced my car for cold-weather driving, I got into it and stepped on the starter. Nothing happened—no, I'm wrong; there was a sputter somewhere under the hood. But further steppings on the starter weren't rewarded by another. So I walked seven arctic blocks to the bus line, and came downtown that way. I didn't think to phone my car-sharing schoolmarmas, and what they will have to say is something I'd rather not think about. And now what should I do?"

"Why, Doc," Gus said, "the wise thing for you to do would be to go on about your business and let us do the worrying. There probably isn't anything much wrong—just one of those cold-morning puzzlers that usually turn out to be pretty simple. We'll tow it over here and have it fixed up and waiting for you at the school by the time you're ready to start home."

WHEN Stan Hicks, the Model Garage grease monkey, towed Nicholson's past-middle-age sedan up to the curb, the shop floor was crowded, so Gus went outside. He got in and pressed his foot on the starter. The starting motor turned promptly, but it didn't start the engine. Gus waited

Weather Puzzler

10 seconds and then tried again—with the same result.

"Move a car out of the shop, and get this one in," he told Stan. "Try a motor heater on it, and see if you can get the engine going. If not, push it in with the wrecker."

Five minutes later he felt a blast of cold air, and looked around from his workbench to see Stan driving Nicholson's car into the shop. The grease monkey got out, shut the shop door, and came over to report: "She started easy after I'd warmed her up."

"All right," Gus said. "Now check the battery."

"Battery's O.K., boss," Stan called after he'd been over it.

Gus walked over to the car. "Then we've got to keep looking. Something keeps the engine from starting up when it's cold. If the battery's all right, it must be something else."

"Ignition, boss?" Stan queried.

"It could be," Gus replied. He took a low-reading voltmeter and checked the primary

ignition circuit. There was no voltage drop between the starting motor and the battery connection on the coil or between the primary connection on the distributor and the engine block.

Gus put away the voltmeter and went over the high-tension circuit. He examined the spark coil, distributor cap, and rotor; they all seemed to be in excellent condition. The wiring looked good, and there was no bad connection. Gus then checked the fuel line and found nothing wrong.

"It must be the compression after all," he told Stan. He knew from the last time he'd seen Doc's bus that it had a case of low compression, but he hadn't thought it would be bad enough to cause hard starting. "Well, I was fool enough to promise Doc we'd have his car ready when school let out, so we'll have to get it fixed. Warm the engine up with the motor heater, and if you can get it going, let it run for a few minutes. Then take the spark plugs out."

When Gus came back from another job,

"Where is the automatic-choke control rod?" Gus asked Doc



GUS SAYS:

If you must use your last year's antifreeze in your car radiator again this year, remember that the rust inhibitor it contained is now probably exhausted. It is always a good idea to add new inhibitor to the old antifreeze solution when you use it a second winter.

Stan was removing the last plug. Gus got his compression tester out of the glass-fronted cabinet in which he keeps his precision instruments. Pressing the rubber adapter into a spark-plug hole, he watched the indicator hand while Stan stepped on the starter. The cylinders tested unevenly, and all showed rather poor compression. Gus squirted oil around the piston rings and repeated the test. There was no improvement.

"What's the oil for, boss?" Stan asked.

"It seals the piston rings," Gus told him.

"If you get a low reading on the first compression test and a higher reading after you've put oil in the cylinders, it shows that the compression is leaking past the piston rings; if both readings are low, it indicates leaky valves. I got a barely fair reading both times on each cylinder; that shows there is some valve leak—apparently enough to allow enough compression to escape to cause hard cold-weather starting."

"I knew that the compression in Doc's car wasn't as high as it should be, but I didn't think it was low enough to cause any trouble. But we haven't been able to find any other cause for his grief, so I guess I was wrong. I'll have to go by the book and re-face the valves."

Gus is one of those top-flight mechanics who get their jobs finished quickly without seeming to hurry. In an astonishingly short time he had the valves refaced and reseated and was shouting for his helper.

"Get into the car and step on the starter when I tell you to," he directed, and poured a little gasoline into the carburetor. "Now!" The engine started promptly.

"That's the job," Gus said. "Let the engine run long enough for it to get thoroughly warm. Then park this bus outside, and bring that Pearson car in and give me a hand with it."

About 3:30 Gus told Stan he'd better run the Nicholson car over to the school. Stan went out, but three minutes later he was back. "Hey, Mr. Wilson," he said, "she won't start!"

"What!" Gus yelled. He went out, raised the hood, and told Stan to try again. Stan did. The starting motor cranked the engine, but the engine wouldn't take hold. "Wait a minute," Gus said. He took off the air cleaner and held his hand over the carburetor air intake. "Now step on her!" The engine started at once.

Gus's head went under the hood. When it came into sight again, his face was red.

"Stan," he asked, "what's the most useful tool in a mechanic's kit? . . . Never mind—I'll tell you. His eyes. Don't ever forget that, kid. If I'd used mine, I'd have saved a lot of time on this job."

"What would you have seen, boss?" Stan wanted to know.

"Come here," Gus said. He indicated the automatic-choke control rod. "Notice anything unusual about it?" he asked.

Stan studied the rod; then he scratched his head. "It looks like it's bent," he said.

"It is bent," Gus told him. "I'll just straighten it and adjust the choke setting, and then I'll take this cold-morning puzzler over to Doc myself. My lunch is past due; I'll get it on the way back."

DOC NICHOLSON was waiting with the three schoolmarms when Gus Wilson reached the school.

"Do you know where the automatic-choke control rod is?" Gus asked.

Nicholson chuckled. "It's one of the few things I do know."

"I thought so," Gus said. "Have you been monkeying with that rod?"

"Monkeying?" Doc looked surprised. "Well, I did make a slight adjustment several months ago. A friend told me that automatic chokes frequently waste gasoline by excessive choking, and that bending the link rod slightly would conserve fuel by keeping the choke from closing all the way. I followed his suggestion. Did I do wrong?"

Gus laughed. "You did!" he said. "In warm weather the change of adjustment didn't cause any trouble—but when it got down below freezing, the quantity of cold air drawn into the carburetor leaned down the mixture too much for starting. What fooled me was that the engine took hold all right after I'd done a valve job on it. That was because it was warm in the shop. But when I'd finished, I parked the car outside, and when I got ready to bring it over to you, the partly open choke caused the same trouble all over again."

"I should have noticed the rod had been bent," Gus went on ruefully, "but I didn't—and I got myself two jobs instead of one. Well, anyway, your low-compression valve trouble is licked now, too."

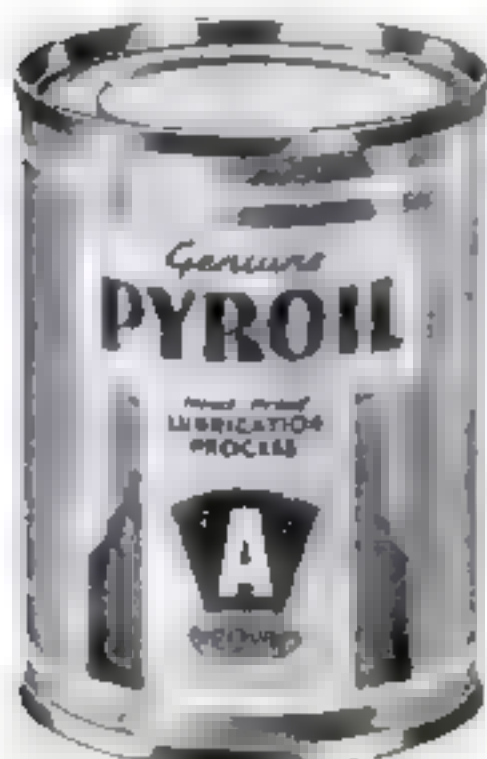
POSTWAR BUSES as well as postwar cars are receiving the attention of designers and manufacturers, many of whom are showing a decided tendency toward streamlining. The model of a highway bus shown in the photograph at the right is the design of Montgomery Ferar. It was put on display at a show staged in Detroit by leading industrial designers of that automobile center to present their ideas for postwar development. The teardrop style is a design feature.



ROAD FILM, scum and blemishes, and oxidation are removed from the finish of a car with the application of a new cleanser and reconditioner that can be rubbed on simply with a cloth after the car has been washed free of dust and mud. A sealer, also made by the Car-Skin Products Company, of New York, and applied with a clean cloth after the finish has been restored by the reconditioner, will seal the color against the elements for several months.



STRETCHING engine lubricant, so that it spreads thinner and further and will get into fine clearances at lower temperatures than untreated oil will, is made possible with a product of the Pyroil Company, of La Crosse, Wis. The penetrating solution is also said to have the property of halting internal corrosion.



CAMOUFLAGING WRECKERS to protect them from enemy fire is studied at the Aberdeen Proving Ground in Maryland by practice on the model shown above, which was built in the model shop of the Ordnance Replacement Training Center at Aberdeen. Because of their usefulness, wreckers have been favorite targets of enemy planes.



Is Your Car Battery a Fair-Weather Friend?

WITH BUT A MINIMUM OF ATTENTION,
IT WILL GIVE YOU MAXIMUM SERVICE

AS LONG as there is a particle of life in it, your automobile battery is constantly at work. It discharges to operate your starter and your lights, radio, and horn when your motor isn't running. When your car is in use, it receives a charge from your generator to restore its power. Even when your car is standing idle in your garage or at the curbing while you relax at a movie, your battery is still undergoing chemical change, for all storage batteries will discharge themselves—completely so under normal conditions in a period of about four months.

Is there any wonder then that your battery needs attention to give you the service of which it is capable? And this care is so easy to give and so well repaid that you will have only yourself to blame if your battery is not an all-weather friend. It is primarily a matter of periodic checking on the cleanliness and tightness of the terminals, and on the amount of electrolyte, as well as seeing to it that the battery receives the proper charge from the generator.

Your battery is a compact, well-regulated chemical factory, but some of its parts may break or wear out, pores may clog, or chemical processes may be upset by impurities, by an electrolyte that is too weak or too strong, by either excessive heat or cold, or by too rapid a charge or discharge.

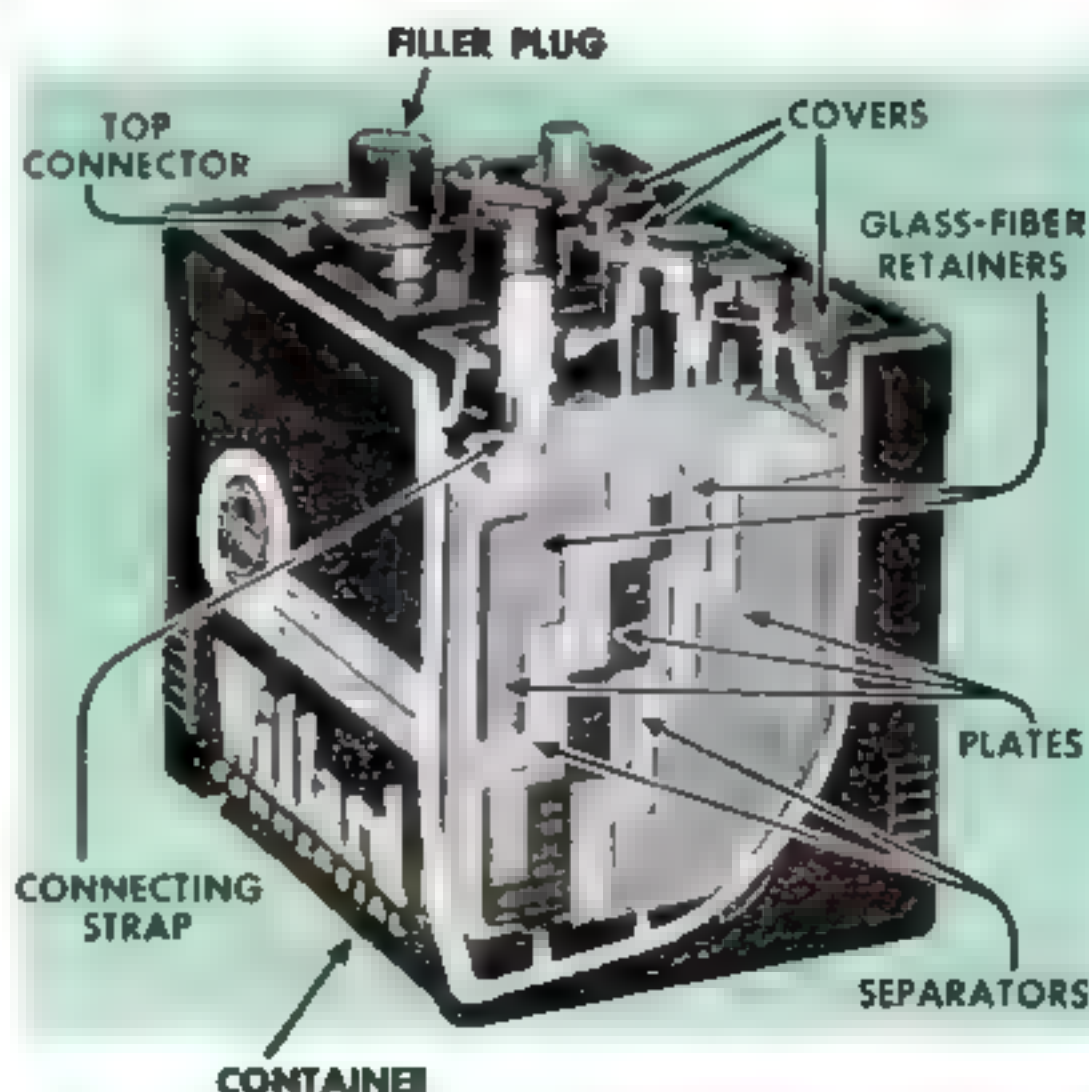
The negative plates of a typical lead-acid automobile battery are made of sponge lead in a framework or grid of lead alloyed with antimony for stiffness, while the positive plates are composed of fine crystals of lead peroxide wedged into a similar grid. Battery sulphuric acid diluted with distilled water is the customary electrolyte, though water that is pure enough to drink may sometimes be used in an emergency with-

out doing damage of any sort to the battery.

During moderate discharge, everything goes along nicely, but as discharge continues, the lead peroxide and sponge lead are changed to lead sulphate, the electrolyte grows weaker, and the voltage drops. Sulphation clogs the pores in the plates and thereby interferes with the circulation of the electrolyte.

Freshly formed sulphate is readily removed from the plates and restored to the electrolyte, but if it is allowed to stand, it gradually hardens, and prolonged charging may be required to make the transformation. If it is neglected too long, no amount of recharging will do the trick. Since an unused battery discharges itself gradually, it should be recharged once a month to avoid extreme sulphation. This is particularly important during gasoline rationing when a car may be left unused for long periods or when short drives don't restore

WHAT'S INSIDE YOUR CAR BATTERY



the charge lost in starting up the motor.

If a battery is discharged to too low a point through excessive use of the starter or the accessories, the plates may become permanently buckled or bent. Buckled plates may split or wear holes in the adjacent separators and then touch and cause a short.

Excessive overcharging is equally harmful. The extra current overheats the battery and results in rapid evaporation of the water in the electrolyte. This may be serious in hot weather, particularly if the excessive rate of charging continues after the battery is fully charged, such as might happen on a long trip. All the energy in the current delivered to the battery is then employed in producing gas, heat, and oxidation of the grids. Excessive formation of gas knocks material off the positive plates, while high temperature increases the activity of the electrolyte, resulting in softening of the plates and deterioration of the separators. Oxidation weakens the grids, decreases their conductivity, and shortens their life. All these destructive actions are accentuated if the electrolyte is allowed to become still stronger through failure to replace the evaporated water.

Should the level of the electrolyte drop below the tops of the plates and remain low for any length of time, the exposed portion of the plates will be subjected to sulphation, while the parts in contact with the electrolyte will be exposed to an overcharge in proportion to the amount their useful area

is cut down, and there will be a corresponding increase in the loss of lead peroxide. Resistance and heating will be similarly increased, more water will evaporate, and the electrolyte will become still stronger.

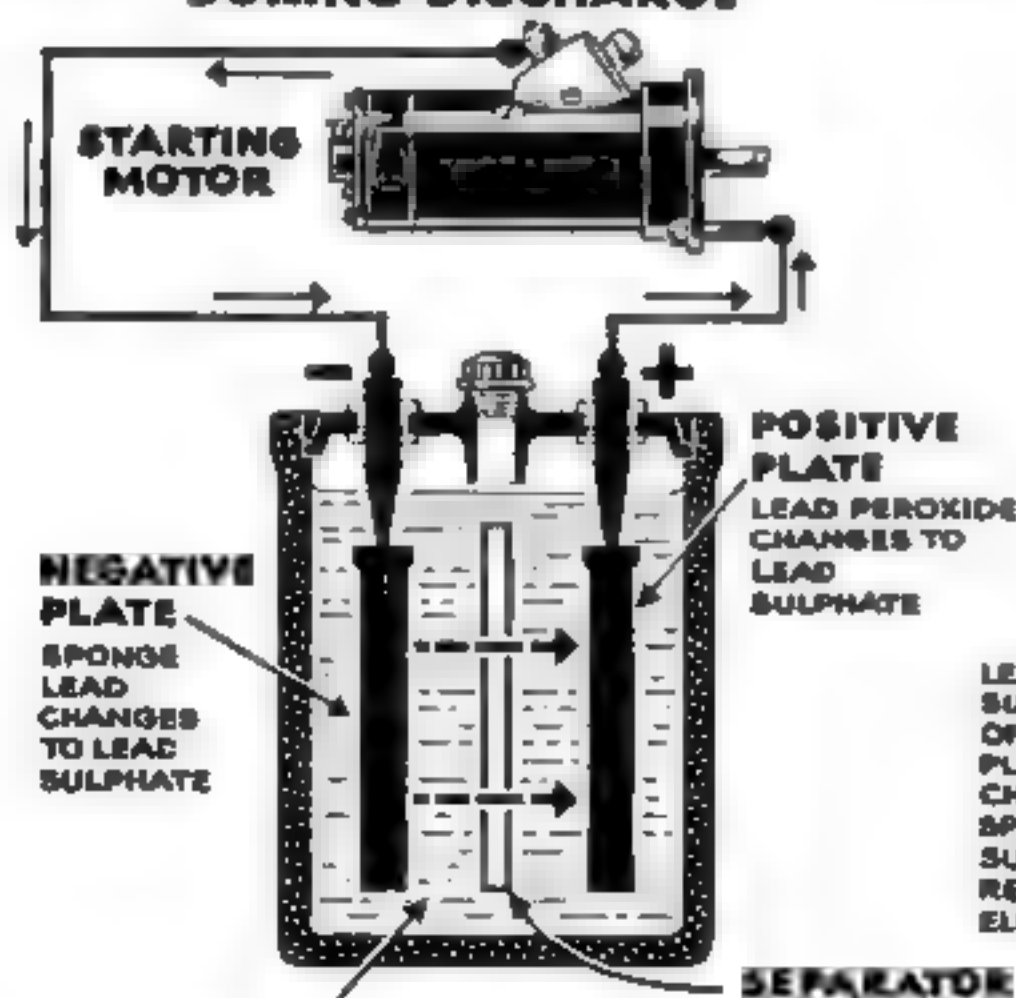
Temperature likewise has its effect on battery performance. In cold weather, the capacity is cut down and, to make matters worse, an engine is harder to crank, thus increasing the amount of discharge each time the car is started. Both freezing and extremely hot weather take their toll. When water in a battery freezes, it expands and loosens the lead peroxide on the positive plates, but in a fully charged battery, the electrolyte will not freeze at a temperature above -96°F . On hot summer days, with the temperature around 100°F . or more, and with the engine adding its heat, a battery should be carefully protected against overcharge.

Servicing a battery is simple. It calls only for specific-gravity tests and a check on the terminals once a month or every 1,000 miles—oftener if you make long, hot trips.

The specific gravity of the electrolyte is tested with a hydrometer and is the reading shown on the scale at the level of the solution. Hold the hydrometer in a precisely vertical position so as not to permit the float to rub against the side of the glass tube and cause a false reading. If the level of the solution is too low for this test, add distilled or approved water and make the test after the engine has been run for

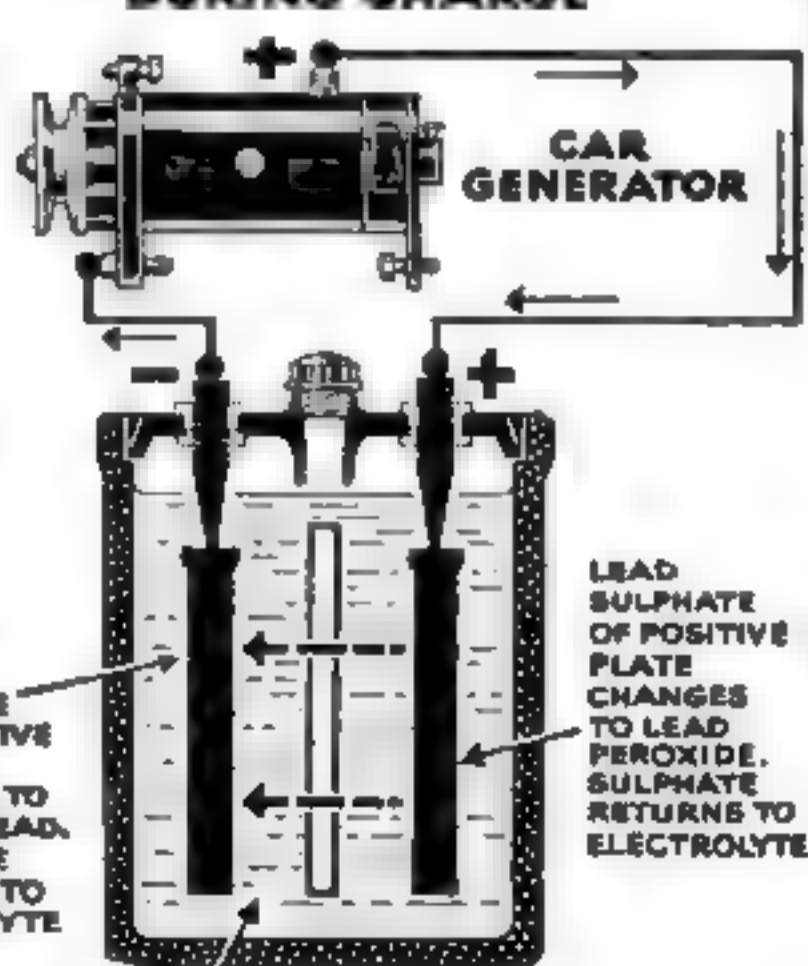
HOW YOUR BATTERY WORKS DURING DISCHARGE AND CHARGE

DURING DISCHARGE

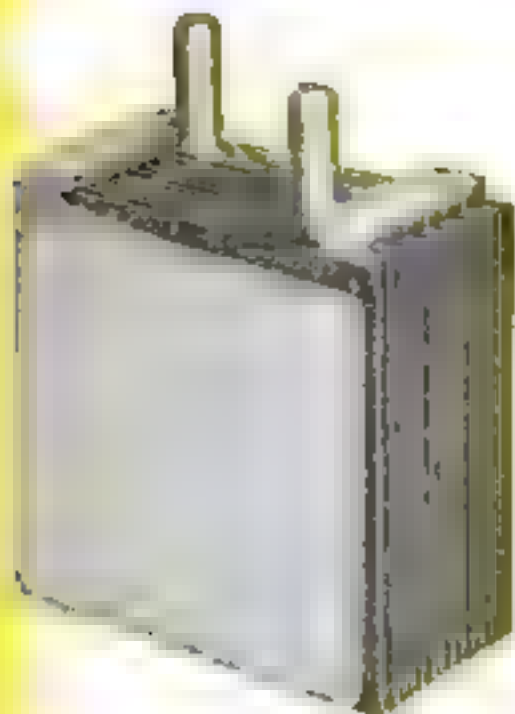


SULPHATE OF ACID UNITES WITH ACTIVE PLATE MATERIALS, WEAKENING SOLUTION. HYDROGEN OF ACID AND OXYGEN OF LEAD PEROXIDE FORM WATER IN ELECTROLYTE

DURING CHARGE

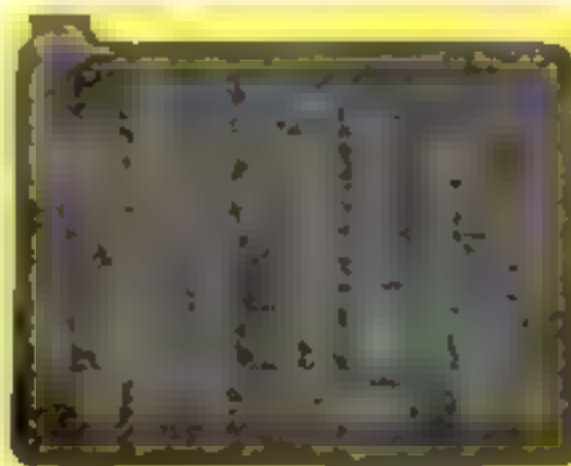
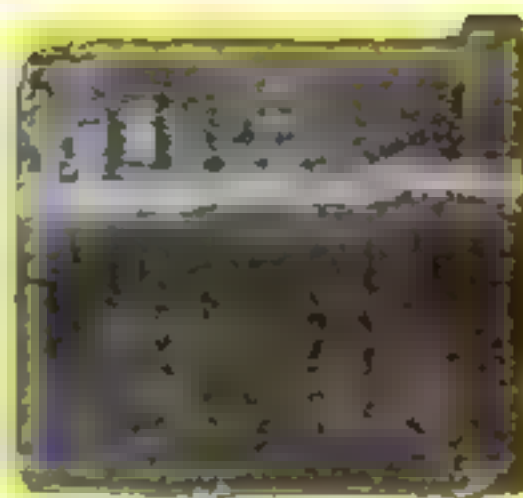


VERY DILUTE ELECTROLYTE MADE STRONGER BY RETURN OF SULPHATE FROM PLATES



EACH CELL of your battery contains a series of alternate plates of sponge lead and lead peroxide spaced by separators. This unit is immersed in an electrolyte of dilute sulphuric acid

A POSTMORTEM on the plates of a dead battery may show causes of failure. The plate at the right is a victim of low water level — its upper portion sulphated and its lower injured by overcharging. Below, left to right, are a plate with buckled and weakened grids and another extremely sulphated. The first is caused by overcharge and the second by too great a discharge



Photos Courtesy Willard Storage Battery Company

half an hour to mix the solution thoroughly.

A fully charged battery has a specific gravity of 1.275 to 1.285 under normal conditions, but a battery at 1.225 will still have sufficient charge to start a car. If the specific gravity is lower than 1.225, remove the battery and have it recharged.

Never add more acid to the electrolyte solution in an attempt to raise the specific gravity. It cannot increase the charge, and it will harm the battery by making the electrolyte too strong. Acid should never be added except when the electrolyte has leaked out or spilled. And never fall for so-called battery dopes. Most of them are simply Epsom salts, magnesium sulphate, and all are definitely injurious since they add impurities to the battery.

If the specific gravity varies more than 25 points between cells, the low cell or cells may be shorted by buckled plates or an accumulation of sediment in the bottom. The condition should be investigated and if possible corrected by a competent battery serviceman, who may be able to replace the defective cell.

Cell voltage is usually tested with a low-reading voltmeter but if one is not available, the approximate voltage may be

judged by turning on the lights and then pressing the starter while the ignition switch is off. A weak cell or cells or a poor connection at the battery or cable terminals is indicated if this dims the lights very

much and makes them fluctuate. If there is a poor connection, heat will be generated at that point and the connection can be located with the fingers.

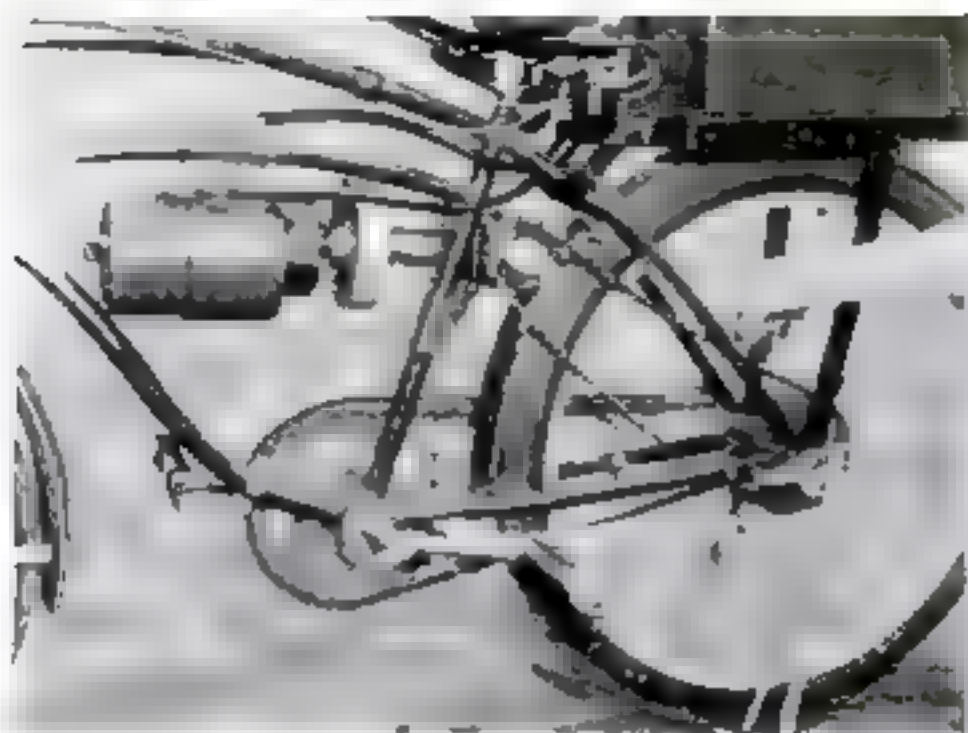
Corroded terminals obstruct the flow of current. Remove them from the battery posts and clean them and the posts with a wire brush. Scrape the inside of the terminals with a knife, wipe them, the posts, and all corroded spots with an ammonia solution, and dry them thoroughly. The top of the battery may also be wiped with this solution if care is taken not to let any leak into the cells. Install a complete new cable and terminal of the proper gauge if either is being eaten away. A thin coating of petroleum jelly will help prevent corrosion.

In making your periodic checks, test also the tightness of the hold-down bolts in the carrier, for if they are loose, vibration will shake the active material off the positive battery plates. Don't tighten them too much, though, as this may warp or break the battery case.



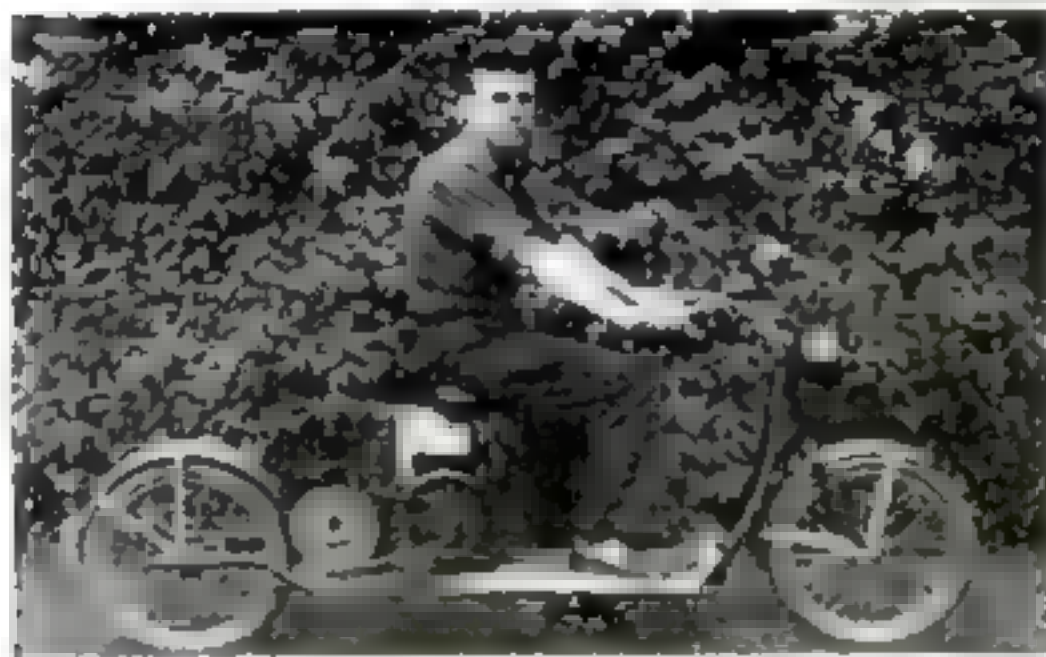
Temperature guide for corrections in hydrometer reading

—AMERICA ON WHEELS—



Mounted on a rear-wheel baggage carrier, an auto storage battery is connected by heavy cable to a motor bolted to the bicycle frame

ELECTRIC BICYCLING is the latest mode of transportation among California movie folk, as shown here by Vivian Austin, of Universal, who demonstrates a bike rigged up by Cyril Holden for gasless riding to the studios. A 6-volt, 15-plate storage battery operates an old Studebaker starting motor, which in turn connects through a reducing gear to the bicycle chain drive for a 20 m.p.h. speed.



GASOLINE PROPELS the motor-bike shown at left, but the 2-hp. air-cooled motor mounted behind the seat takes only 1 gal. each 55 miles. The bike frame was built of conduit by Omer J. Devau, of Derby Line, Vt. Equipment includes 20 by 2.125 wheels and tires, a loose V-belt for the clutch and a tightener operated by foot, and sprockets and a chain to transmit power to the rear wheel. A generator operates the lights. The bike will do 45 m.p.h. and climb 15-deg. hills.

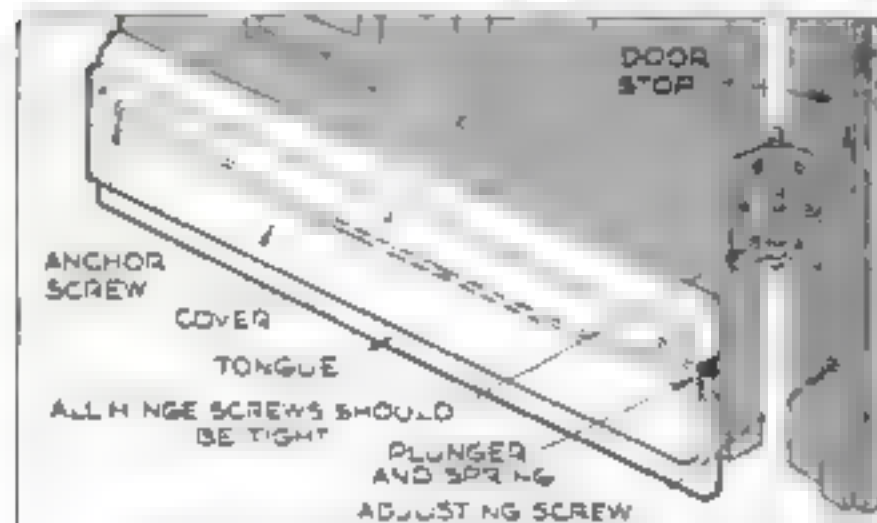
SPEEDING? Well, hardly, in this 1901 Oldsmobile. The traffic cop may be booking some bets on how long the old girl will keep rolling. Her owner, Lyman E. Greenlee, of Anderson, Ind., sent the picture after seeing a P.S.M. article (March, '44, p. 135) describing a model of a 1903 Oldsmobile. He has kept his horseless buggy in perfect running order and, until the advent of gasoline rationing, drove it every summer.



OF INTEREST TO **HOME OWNERS**

SEALED PORTABLE FURNACES that weigh only 45 lb., carry their own fuel supply, have a gasoline-powered blower, and provide a forced flow of warm air have been developed for the Army Air Forces. They were built for both ground and flight applications and have been tested at an altitude of five miles and at a temperature of 70 deg. below zero. Home use is expected after the war by the manufacturer, the Norge Division of Borg-Warner Corporation, of Detroit, which reports that one unit is capable of heating an average single-family house.

AUTOMATIC WEATHERSTRIPPING now seals the opening between a door and its sill tightly when the door is closed, yet is raised flush with the bottom of the door to clear the thickest carpet when the door is swung open. This new device, manufactured by the Thermal Company, of Philadelphia, works with a stiff leaf spring that forces a sliding panel in the weatherstripping down when a plunger makes contact with an adjustment screw inserted in the jamb near the door hinge, as indicated in the drawing below. The unit can be sawed to length and installed by an amateur.



LIGHT ON THE LIGHT SWITCH is a new idea for locating it in the dark and saves smudging of the wall by groping fingers. A tiny, low-wattage bulb mounted on the plate gives a soft glow when the lamp controlled by the switch is off, but the pilot light goes off automatically when the room light is turned on. The plate fits any standard switch. It can as readily be adapted for use with three and four-way arrangements, according to the maker, the Associated Products Company, of Columbus, Ohio.



FUMBLING WITH PLUGS won't be necessary when an invention of Delbert C. Blackmon, of Olean, N. Y., comes on the postwar market. A guiding post on the plug will automatically align the prongs with the receptacle slots.



CRAFTSMEN AT WORK

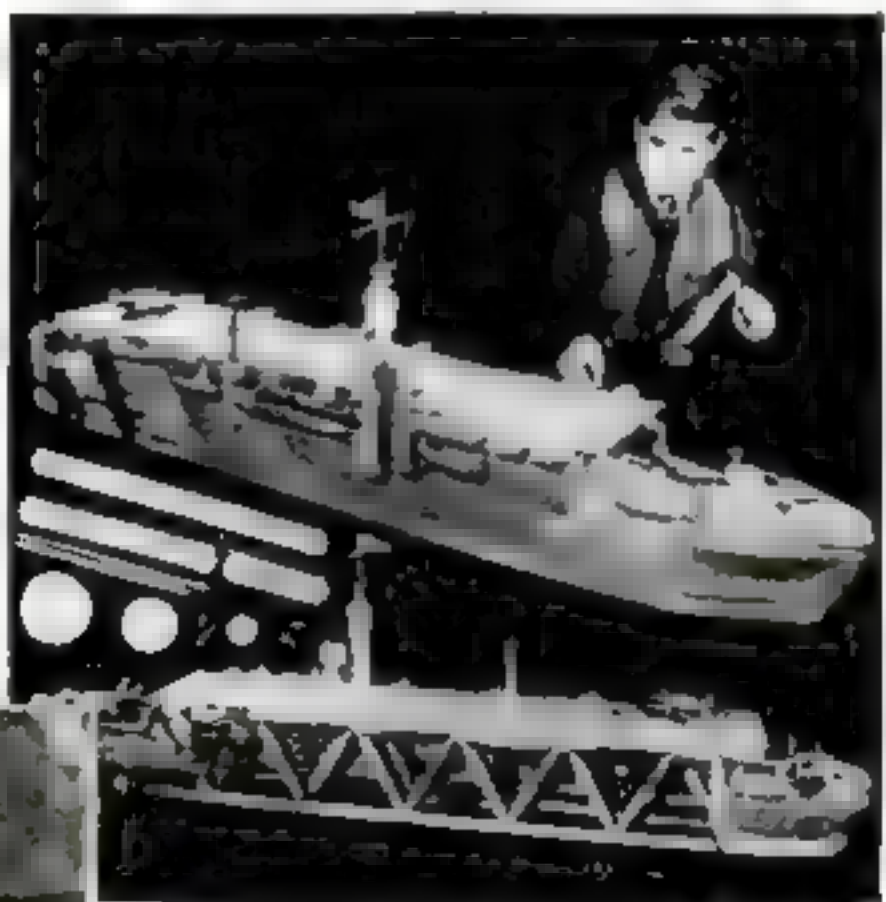
USING 1,047 ITEMS at a cost of \$2 and 120 hours' labor, Corp. Edward V. Barry (seated below), of Millville, N. J., and the Army pilot school at Greenwood, Miss., made the 1" to 1' model Link Trainer shown. It works just as its prototype does.



LILLIPUTIAN FURNITURE that is an exact copy of eighteenth-century antiques but one seventh the size of the originals is made by Angus M. Dowling, of New York, in spare time from his job as a telephone engineer.



PUTTING THE WIND TO WORK, chief petty officers at the naval air base at Kaneohe, Hawaii, rigged up this windmill washing machine for their clothes.



CARDBOARD GIRDERS, wooden dowels, wooden wheels, and locking washers are included in a new construction set invented by W. N. de Sherbunn of Mt Kisco, N. Y. Parts of two sets were used to build the large ship model shown.

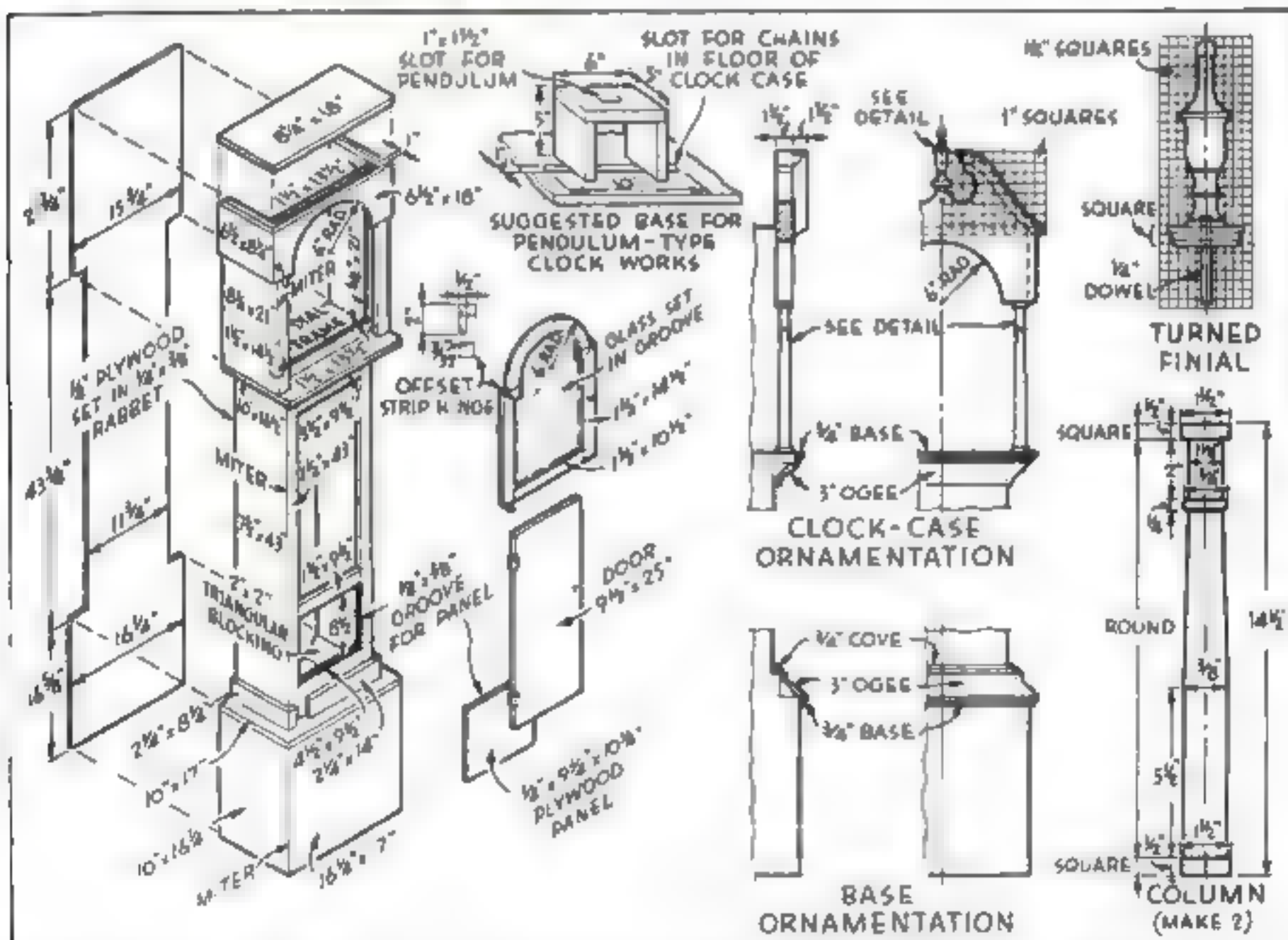
Early American

THIS handsome clock, distinguished enough to be cherished in a family for generations, is not in the least difficult for a careful craftsman to make. The one shown in the photo was built principally of black walnut, together with some 1/4" fir plywood and miscellaneous pieces from the shop scrap pile.

Both curved moldings that form the top of the broken pediment were taken from an old Victorian bed; they were cut down to length and a return shaped across the ends. All other moldings are stock shapes and sizes, the kind to purchase being suggested in the ornamentation details in one drawing. The finial is turned from maple, unless you are lucky enough to find a brass one of the right size.

The kind of clockwork used depends on what the builder happens to have or can obtain. A pendulum mechanism with or without weights, an electric clock motor, or a simple spring-powered clockwork taken from a wall clock are all adaptable to the design. In the event that you dispense with a pendulum-type works, the pendulum-support base shown in the drawing may naturally be omitted.

In front of the clock face, the glass door is held by two offset strip hinges that are fastened to the top and bottom of the door with two screws apiece. A third screw through each hinge into the wooden frame acts as the pivot upon which the door swings.



Dimensions of the clock-case parts are shown here. The mounting of the works varies with the kind used.

Grandfather Clock

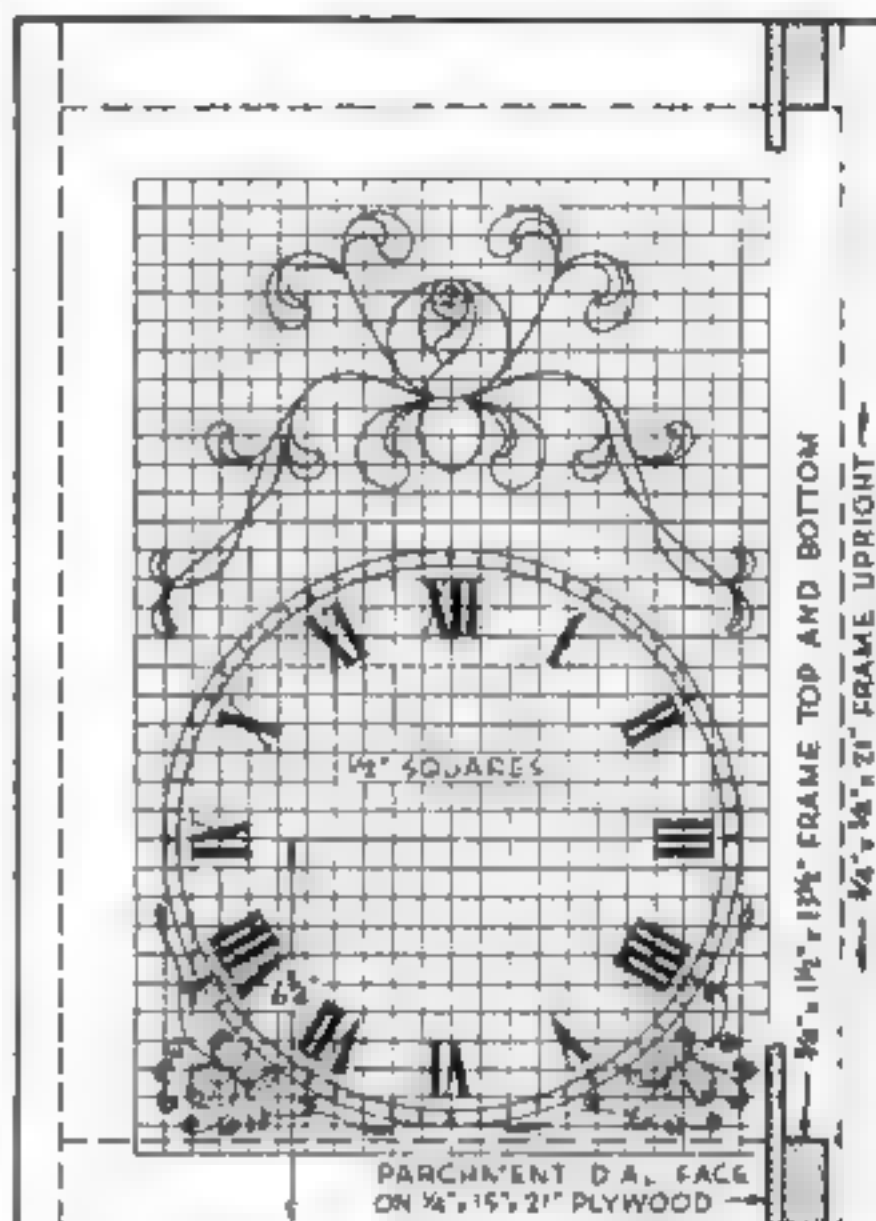
By
NORBERT ENGELS

Since the hinge pivot lies outside the door, the overhanging door arch doesn't interfere.

The rectangular dial, a piece of real or imitation parchment mounted on plywood, is secured inside the clock by support blocks installed behind it. Shown in the photo is one design for decorating the face; a second pattern, a rose with trailing vines, is given in a drawing. The latter design may be either left black and white or brown and white, or else water-colored with pleasing shades of green and red. In any case, the dial should be finished off with a wash of weak coffee to give it an antique look.

In assembling the clock, all support blocks are glued and screwed, and all moldings are suitably backed up with triangular and rectangular pieces. A good way to fasten in place the columns which frame the dial is to drive a brad part way into the top of each post, sharpen the head of the brad, and then force the post into position. Wood screws driven up through the bottom board then hold the posts securely. The cabinet doors may be fitted with plain butt hinges and a simple brass knob.

For the finish, something quite important in a piece of this nature, the following sequence is suggested. First, clean and sand the entire structure; then give it an application of paste filler. When the filler has dried, sand the clock lightly and rub it thoroughly with fine steel wool saturated in linseed oil. Wipe off the excess oil, let the clock stand for about 36 hours, and then repeat this oil rub. After three or four such applications, apply several coats of wax with



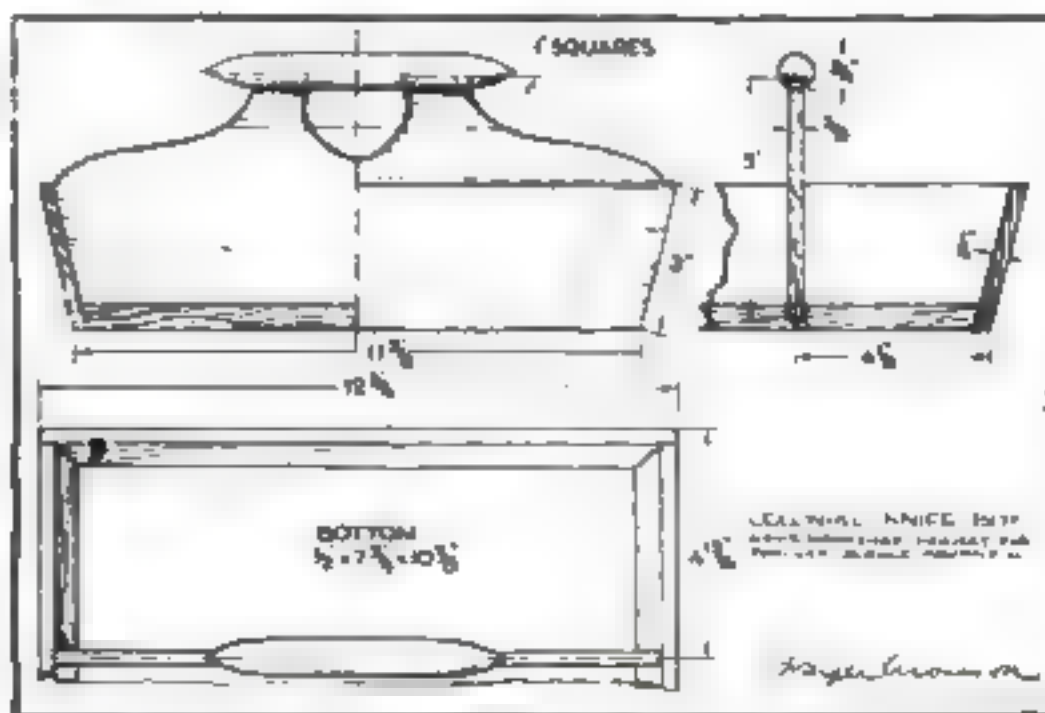
A wash of weak coffee applied to the dial will do wonders in giving it a fine old-parchment finish

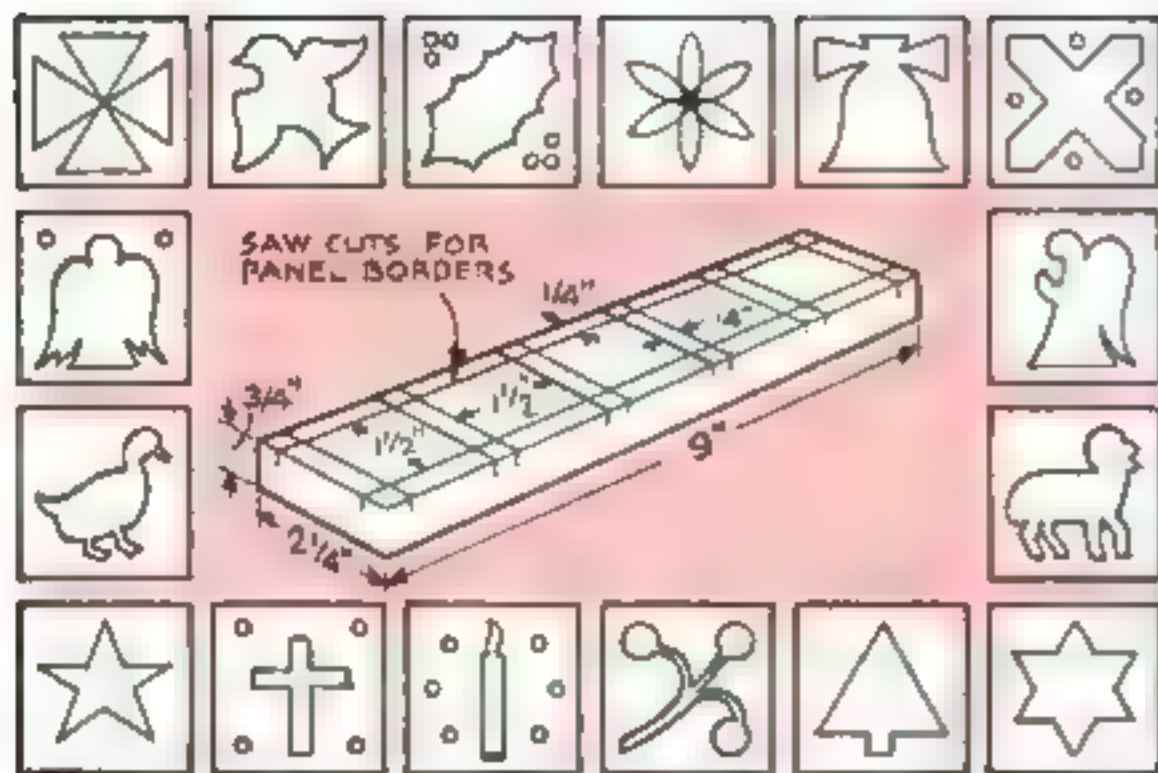
fine steel wool and polish the clock carefully. The deep, soft finish that results—provided you have devoted ample time to the rubbing—will harmonize perfectly with the simple dignity of the clock.

Old-Fashioned Knife Box Has Attractive Hand-Rubbed Finish

WHETHER used as a knife box, a fruit bowl, or a knitting box, this attractive example of early nineteenth-century craftsmanship will grace most contemporary rooms. Use soft pine throughout, with the floor and sides beveled to give the right pitch to the sides. Assemble with glue and

brads that are set well beneath the surface. The handle is a $\frac{3}{8}$ " dowel, grooved to fit the partition. Finish with thorough sanding, taking pains to round all edges; then stain with burnt umber in oil, add a thin coat of shellac, sand once more, and finally rub in colored wax.—JOSEPH ARONSON.





Old World Embossing Board for Traditional Holiday Cookies

NOTHING will add more to the enjoyment of Christmas than an accumulation of the small, traditional accessories that have been brought to America from the holiday customs of many lands. Here is one—a *spring-erle* board of the type carved in the past by the finest European cabinetmakers for their families. Figured with Christmas designs, it is used as a mold to emboss delicious cookies.

Cut the board from maple, or other suitable hardwood, and carve the panels with appropriate figures, a number of which are suggested above. A sharp knife, chisel, and drill point

will be found useful for carving; the drill point is especially good for making the small holes.

The traditional Old World Christmas cooky is made from $\frac{1}{2}$ lb. powdered sugar, 2 eggs, 2 cups flour, and 2 teaspoonfuls anise seed. Stir the eggs and sugar until light, add the flour gradually from the sifter, stirring until the dough is stiff, and then roll the dough $\frac{1}{8}$ " thick. Flour the design board and use heavy pressure on it. Cut out the squares and let dry for 10 hours at room temperature. Bake on buttered tins sprinkled with anise seed in a moderate oven until light yellow.

Christmas

Curious Little Dolls Made from Peanuts and Scraps of Cloth



TINY, interesting dolls like those in the family shown at left can be made from peanuts. The steps are outlined in the drawings below. In addition to the adults, children, dog, and chickens shown, costume dolls such as Indians and period figures will add variety to a display.

Be sure to select a peanut of the general shape desired in the finished doll. Draw in the features with India ink; then paint eyes, mouth, and coloring with water colors. Crepe paper or bits of cloth form the clothes, and unraveled soft rope is glued on for hair. Carve the feet from wood and drill small holes so they can be glued on the legs.—DAISY WELCH.

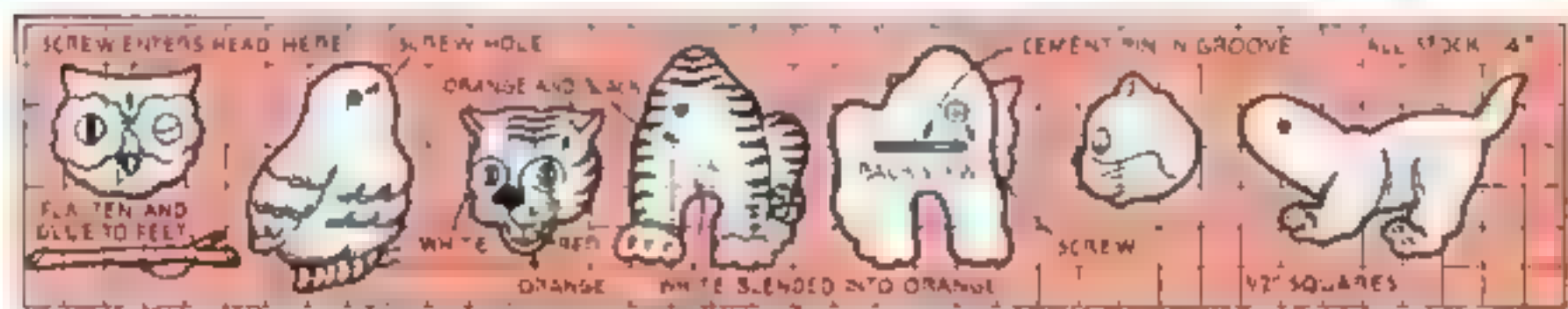


Clever Animal Pin Has Waggish Head

ANY of these roguish little animal lapel pins will delight most girls. They are sawed out or carved in two pieces—the bodies from $\frac{1}{4}$ " wood and the heads from thinner stock.

Shown in the drawings are a wise old owl with a knowing wink, a tiger more good natured than bad, and an inquisitive kitten. Also given is a rear view of the tiger showing how it is slotted to permit an ordinary safety pin to be cemented in place.

Cut out the body and carve it simply, if you wish, to round the edges and bring out the important lines, then drill an oversize hole for a small wood screw to turn in freely, and countersink the hole from the back. The head is shaped next, and both pieces are sanded and enameled in striking colors. Finally, put the screw into the back of the head at the point indicated, passing it through the body and a light cardboard washer.—E. W.

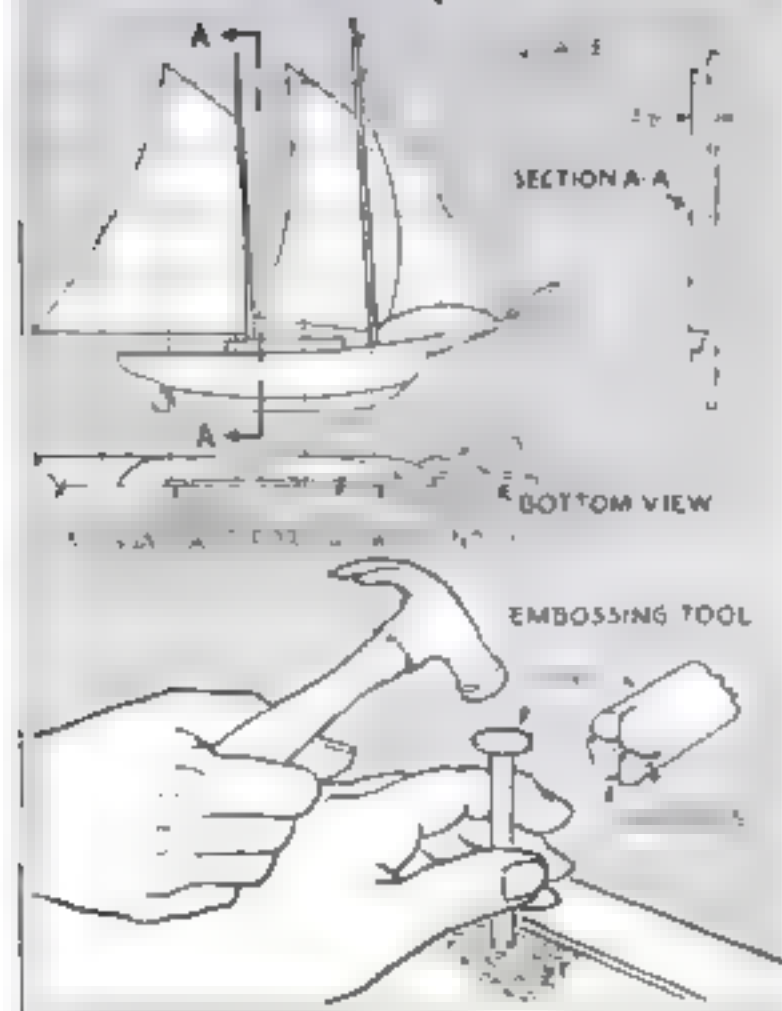


Rakish Swordswording Boat Carved in Relief on White-Pine Board

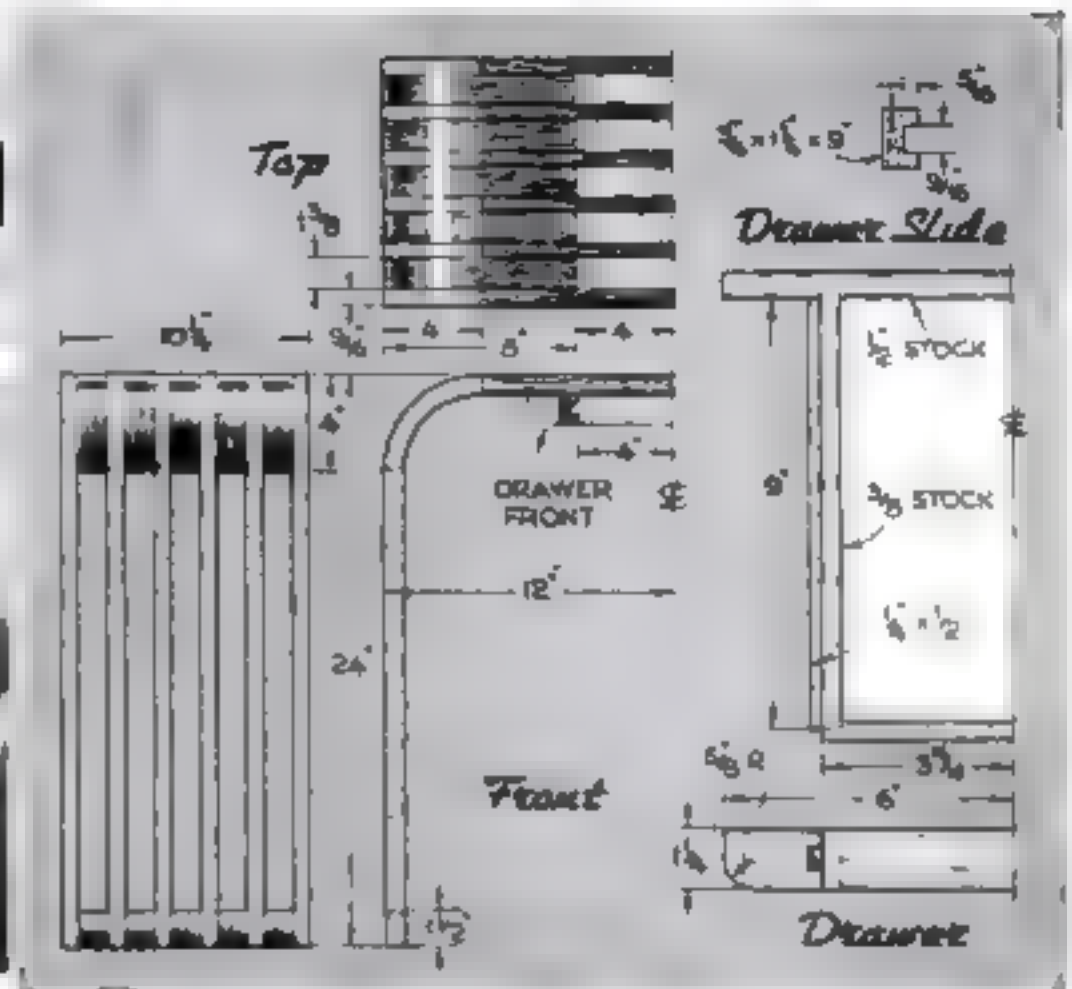
THERE is double interest in carving a plaque—that in the actual carving and the lasting pleasure of seeing your work on your wall or that of a friend. This swordfishing boat, with its odd rail, or "chair," at the tip of its bowsprit, is an unusual design not seen in many waters, though such boats are frequent sights in the fishing harbors of Nova Scotia.

Lay out the ship on squares drawn lightly on a 1" by 8 $\frac{1}{2}$ " by 10 $\frac{1}{2}$ " piece of white pine; then carve out the background with a sharp jack-knife and chisel to a depth of $\frac{3}{8}$ ". Next, shape the lines of the ship, billowing the sails, cutting back the masts, bowsprit, and keel so they appear to be at the centerline of the boat, cutting back the cabin somewhat less, and curving the hull gracefully. Then bevel the edges of the board.

An attractive background can be obtained by sawing off square the end of a 4" spike and slotting a cross on the square end. This gives you four points that can be punched over the entire back surface for a hammered effect. After this, go over the outline of the ship again with a sharp knife to make it stand out cleanly; then sand the ship and beveled edges and give them a coat or two of clear lacquer or shellac. A mahogany or other stain or wood dye is then applied to the background in order to complete the project.—B. BRIDGEWATER.



End Table Features



By CHARLES and BERTRAM BROWNOLD

SIMPLE, graceful lines characterize this utility end table, while its construction of glued strips gives it unusual strength for such a light piece. Its modern design will fit in with other modern furniture and will not be out of place in the average room that leans to no particular period. The two-toned effect in the model shown was achieved with mahogany and whitewood, and it accentuates the modern style.

Making up the top and leg assemblies by gluing strips under pressure provides a sturdiness that would be hard to obtain with customary stock. This is especially true at the curves where the grain of the legs runs vertically and that of the spacers is horizontal. For this reason, the table will find a variety of special uses, such as holding a portable sewing machine or a full-size typewriter. Dimensions can be changed, of course, to suit particular needs, but the $24"$ height and $10\frac{1}{4}"$ by $24"$ top detailed in the drawing will be found satisfactory for most purposes.

Glue up the two leg assemblies first, using $9/16"$ stock for the six legs of each and $1\frac{1}{2}"$ stock for the five upper and five lower spacers. A cardboard guide (Fig. 1) will be handy both for marking the curves and for planning the most economical way in which to lay out the work. Make up one leg assembly at a time between the vertical faces of a holding jig that can be anchored with bench stops, and glue it under pressure, as in Fig. 2.

When the leg assemblies have dried thoroughly, say on the next evening, arrange them in the holding jig, and fit in and glue (Fig. 3) the 11

Laminated Construction



strips that make up the top, clamping them firmly, as shown in Fig. 4. Then, when this glue has set, sand the entire table carefully with the grain to get all joints absolutely smooth, glue and screw on the drawer slides shown in the drawing, and finish with shellac, varnish, or stain.

If long bar clamps are not available, efficient clamps can be made from hardwood blocks screwed to stock of suitable length, as in Fig. 5. A bolt passing through a nut recessed in one of each pair of blocks provides pressure. In use, tighten the bolt against a metal plate on scrap stock to protect the work.



Sharpening Jig Keeps Edge of Tool Dressed at Proper Angle

EDGES of plane irons and chisels can be kept at the correct angle in a sharpening jig consisting of an oilstone and a block and roller in a guide, as illustrated below.

Cut one end of the block at a 30-deg. angle, which is within the 25 to 35 deg. recommended by authorities as that at which the tool should be held from the stone. Drill it for two bolts, set in counter-sunk nuts, and countersink the bolt heads; then drill a hardwood plate to go over the bolts and hold the tool to the block. Mark the sloping face with parallel lines as a guide

for setting the edge of the tool at right angles to the stone.

Adjustment of the tool angle is made with a bolt and wing nut that secure the roller-axle arms. This will be about right when the block is parallel to the base, or it may be measured with a 30-deg. angle cut in a second block, as at right below.

Make the base to fit your oilstone, attach guide strips at the sides of the run to suit the width of the roller, and design the length so the tool won't run off the stone at either end.—C. and B. B.



Winch Atop Miniature Well Draws Up Cigarettes

CIGARETTES are delivered attractively and with dispatch when the winch of this miniature well is turned to draw them up out of their container. Lowered back into this desk or table decoration, they stand with their ends almost flush with the "brick" wall.

From $\frac{1}{2}$ " stock cut five rings 4" in diameter and with $2\frac{1}{4}$ " holes, and paint them brick red on the outside. When the paint has dried, clamp them together and make 12 parallel, equally spaced saw cuts along the cylinder so formed to a depth of about $\frac{1}{16}$ ". This leaves a series of white marks showing through the red paint and, when the rings are staggered, stacked, and glued in the final assembly, will represent mortar. For the mortar between courses, cut rings of white cardboard, as in Fig. 1. If the cardboard isn't as thick as the saw cuts, use two or more pieces between each row of "bricks."

Make the base from $\frac{3}{4}$ " stock and recess in it a $2\frac{1}{4}$ " diameter hole to which is fitted a disk that will pull easily through the well. The winch may be lathe-turned, or two rings cut from $\frac{1}{2}$ " plywood may be glued to the ends of a dowel. Slot one end to take a right-angle bend in the wire of which the crank is formed; then assemble



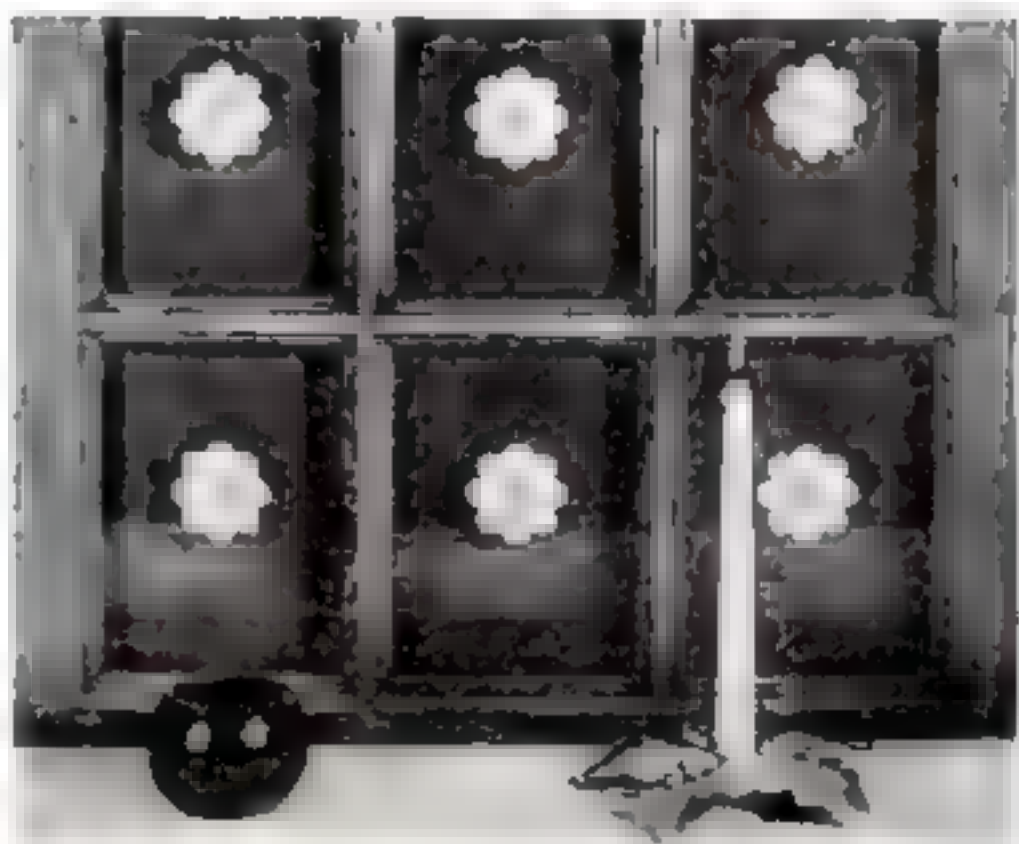
the winch between uprights mortised into the "brick" wall. Knot a cord, pass it through a counterbored hole in the disk, and attach the other end to the winch. These parts are shown in Fig. 2.

The roof is made of four light pieces of wood put together as in Fig. 3. Tack on strips of cardboard that have been cut with a razor blade to indicate spaces between shingles. Strips are put on the ends to represent clapboard.—C. and B. B.

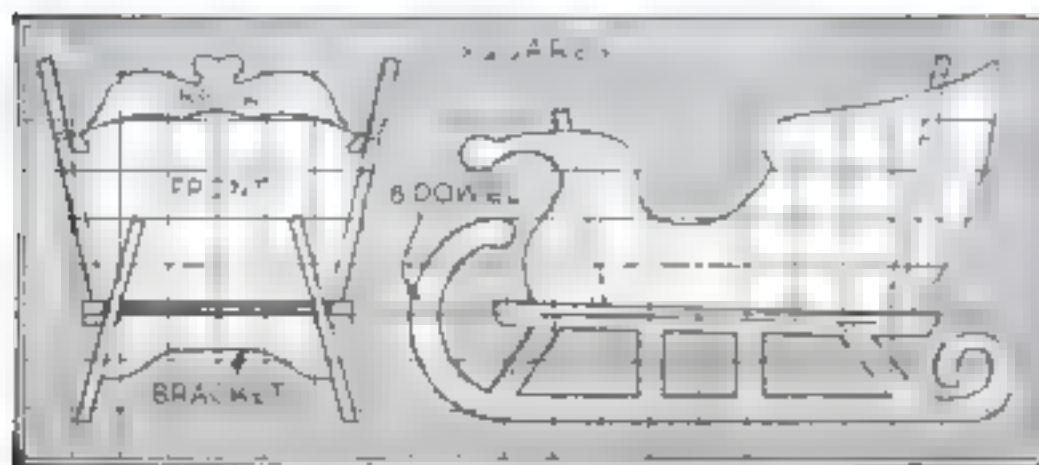


Paper-Doily "Snowflakes" Add a Christmas Note to Windows

CUT from the centers of simple lace-paper doilies that can be bought at any 10-cent or department store, frosty-looking snowflakes like those shown at right are a decorative novelty that will dress up your windows for the Christmas season. Choose doilies from which eight-sided flakes can be cut, or take them from several different packs to get a variety of shapes. Glue a snowflake to the center of each small pane, or attach them in irregular patterns on full-size panes.—B. N.



DECORATIVE SLEIGH CENTERPIECE



PLYWOOD or other light stock is used for this holiday table or mantel ornament that is ideal for holding nuts and candies. The piece can also be set up attractively with a ribbon harness attached to half a dozen toy reindeer. A toy Santa will add to the effect.

Lay out the designs for the two sides and the front and back on squares and cut them out with a hand coping saw or a jigsaw.

Assemble the pieces with glue and small brads or escutcheon pins.

White enamel trimmed in red and green is always appropriate for Christmas. Be sure the base coat of white has dried thoroughly before adding the decorations, or the colors will run. The designs may be put on with a camel's-hair brush, or transfers may be used.—WILLIAM FREEMAN.



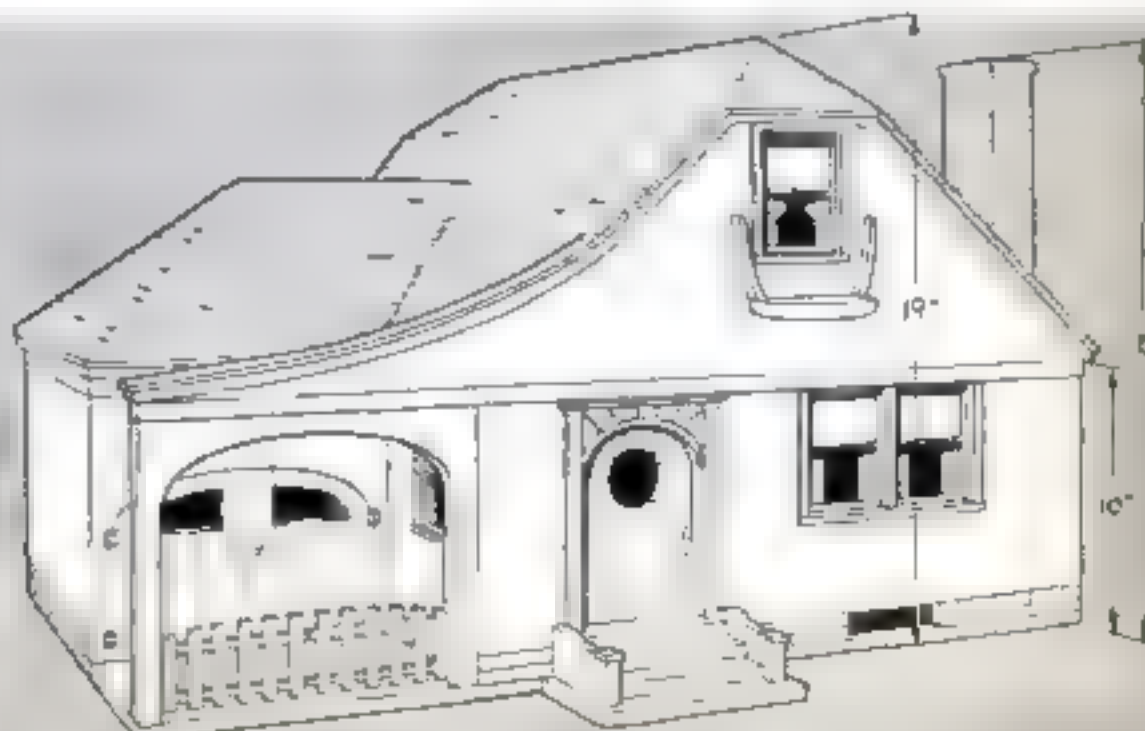
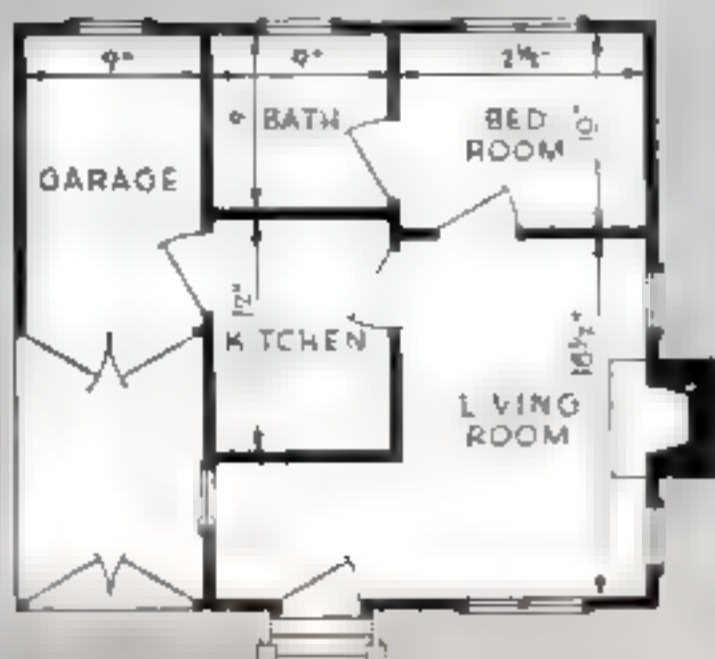
Four-Room Doll House Has Attached Garage

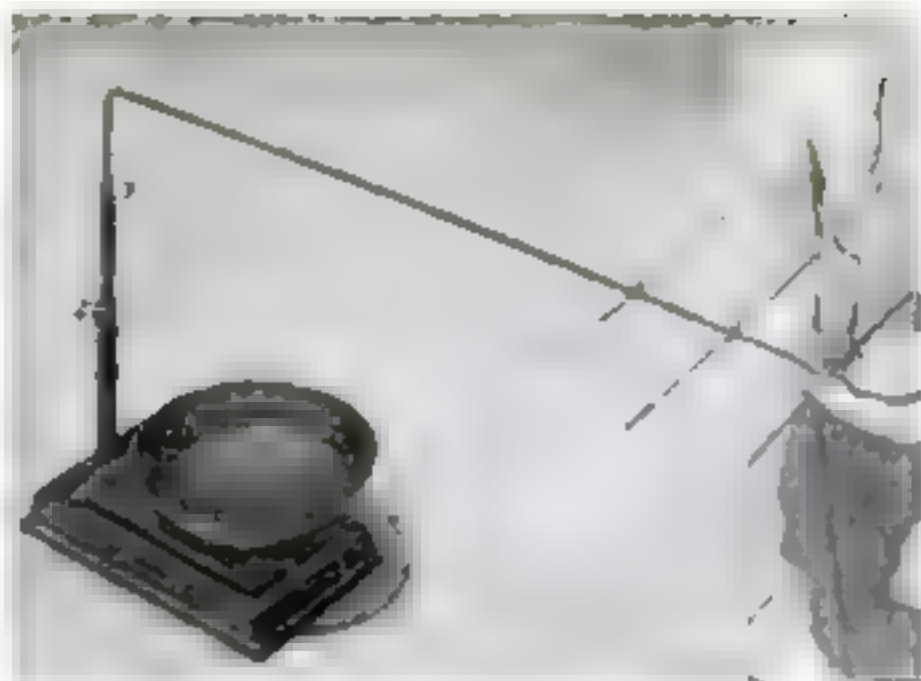
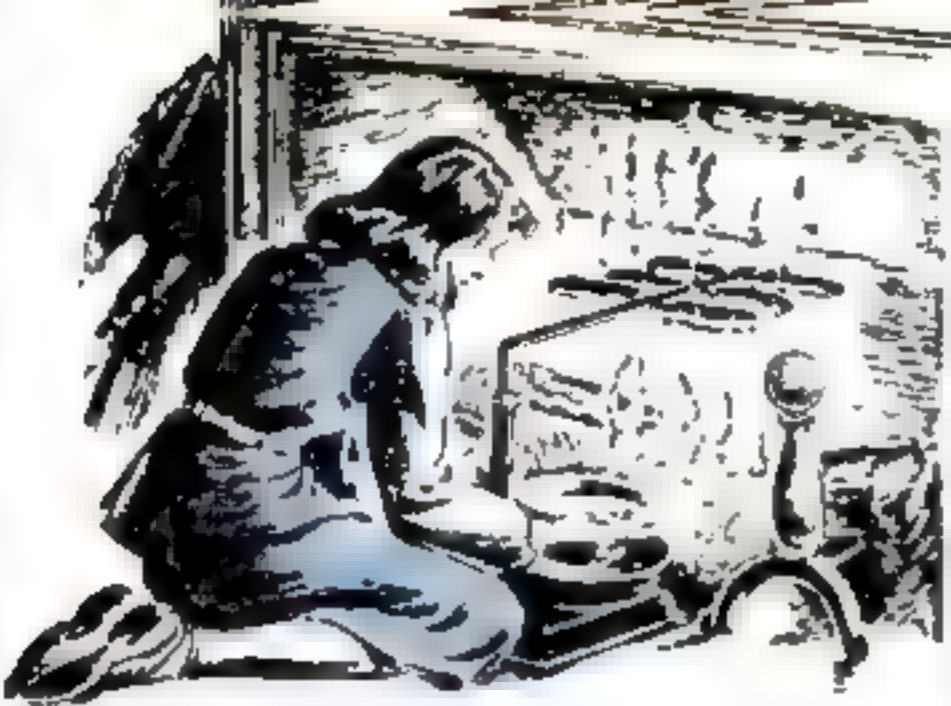
LIVING room, kitchen, bedroom, and bath are included in this bungalow-type doll house along with a garage. They are scaled reasonably close to take the conventional doll furniture on sale in 10-cent stores and small toy shops. The roof is separate from the house and may be hinged on or built to lift off so the young owner can arrange her furniture as she wishes.

Plywood $\frac{1}{4}$ " thick is used throughout in

the construction, and most of the pieces are simple panels—such as outside and inside walls and the roof sections—that can be cut to the shape and size indicated. Assemble the pieces on a plywood base that will serve as a floor and give added strength. If the roof is built similarly on a ceiling, it will be easier for the little housekeeper to handle and will be steady when set in place. Small parts such as doors, steps, and chimney can be cut from scraps. Use $\frac{1}{2}$ " brass hinges on the doors and gates and white roundhead pins for doorknobs. Windows may be cut out or drawn in with India ink, and shutters may be added if desired. Curtains and appropriate drapes are attractive.

In finishing the house, put on first a coat of flat white; then, when this has dried, add ruled markings with India ink. Score the wood for bricks, tile, and shingles. The desired colors can then be applied. Finish the interior with a different color scheme for each room—W. F.





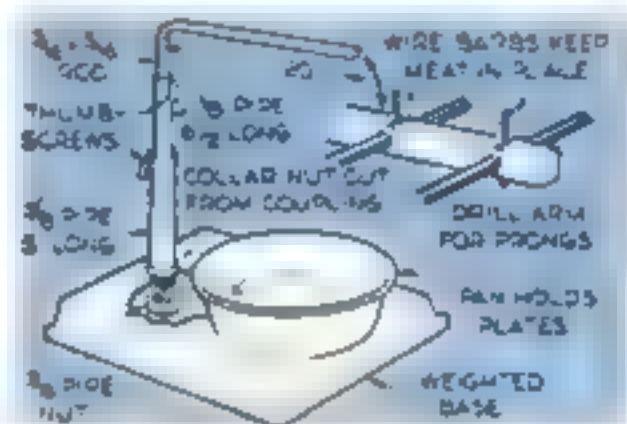
Adjustable Broiling Arm Telescopes to Suit Height of Fire

STEAKS and frankfurters can be broiled to the taste of the most discerning on this stand. It has an arm that can be telescoped to just the right height for any kind of fire, and is equally useful for winter picnics by a cozy indoor fireplace and for the garden and camping trips.

A discarded casting of suitable shape, a heavy pulley, or the bottom section of a laboratory ring stand may be used as the base, weighted, if neces-

sary, by a piece of lead attached to the underside. The plate warmer may be a frying pan minus the handle.

Two pipes that will telescope serve as the upright. Mount the larger on the base with two nuts, and drill and tap both for thumbscrews. Bend a length of $3/16$ " square iron rod for a 20" arm that will support a small steak or a dozen franks. Drill it for prongs made of $3/32$ " rod and barbed with wire as shown.—J. M.



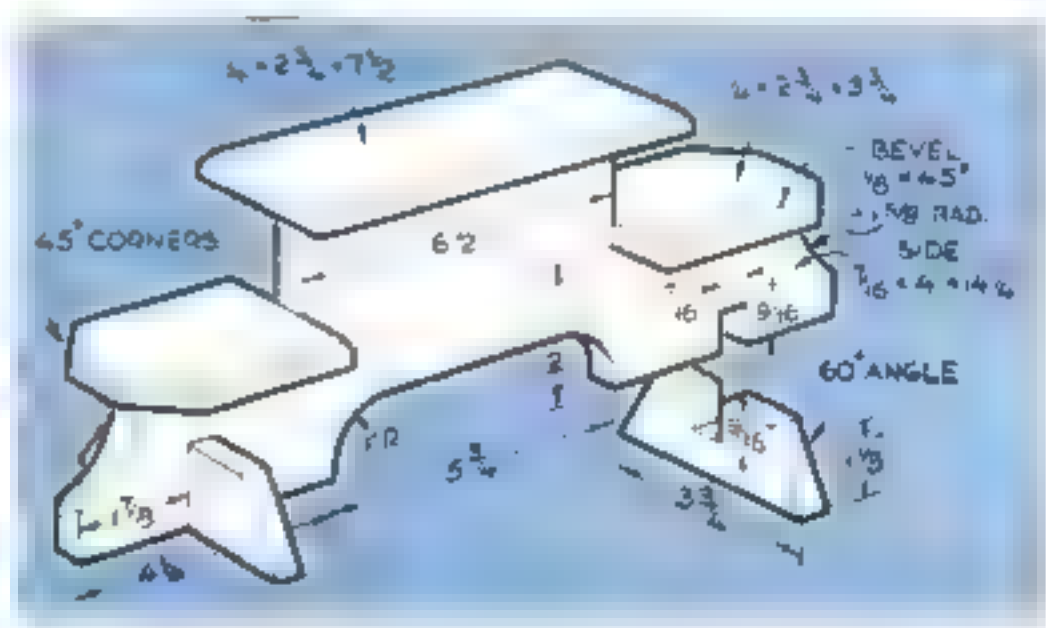
Simple Terraced Stand Holds Plants in Orderly Arrangement

THREE shelves placed at two different levels on a light wooden support make an ideal stand for holding small plants on a window sill, table, or mantel, or for displaying statuettes or knickknacks. The piece can be sawed out and assembled easily in one evening. It requires nothing but a few scraps left over from other projects. Plywood may be used for either the shelves or the support, but since much end grain shows, solid stock will finish better.

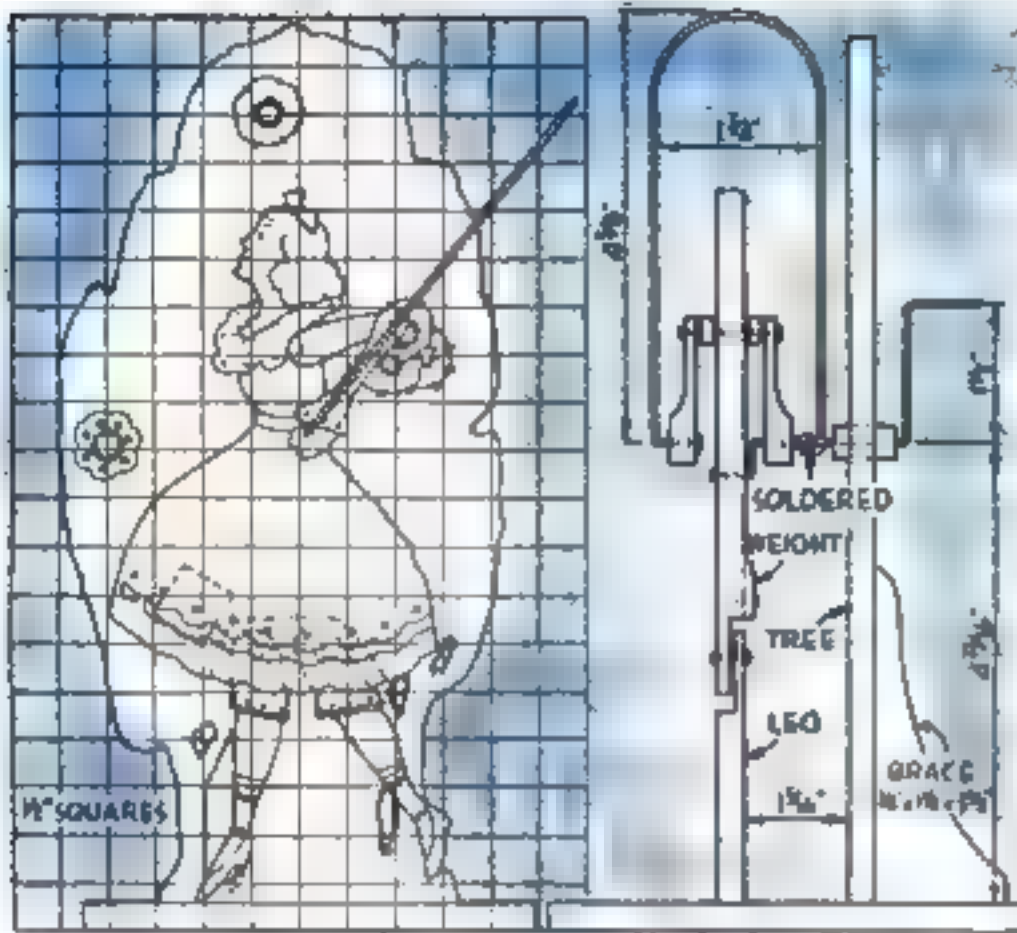
Cut the three shelves to the dimensions

shown, saw off two corners of the smaller shelves, and bevel all edges halfway down from the top except the inside edge of the two small pieces. Saw out the large supporting member next, notching it as in the drawing to take the two notched feet. Sand all parts smooth and assemble with glue, securing the shelves with small brads, which may be set and puttied if desired.

Enamel blending or contrasting with window trim, or a stain to match furniture, is an attractive finish.—EDWIN DREWITZ.



GIRL SKIPS ROPE IN LIFELIKE TOY



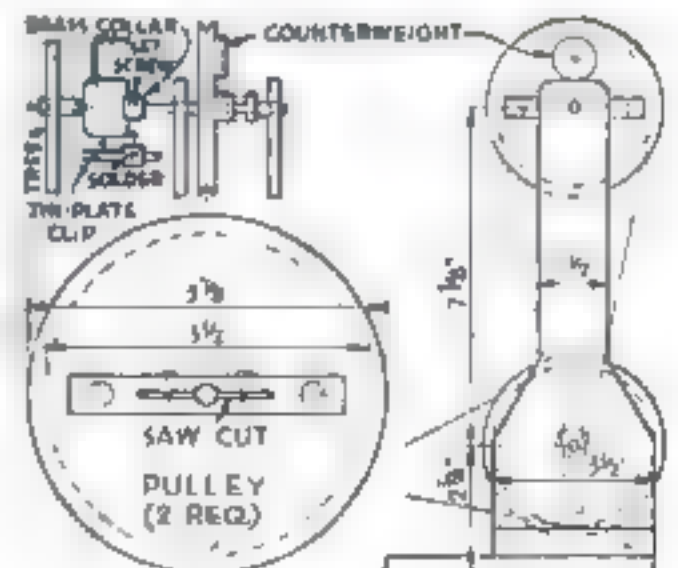
By
EDWARD J. THATCHER

Christmas

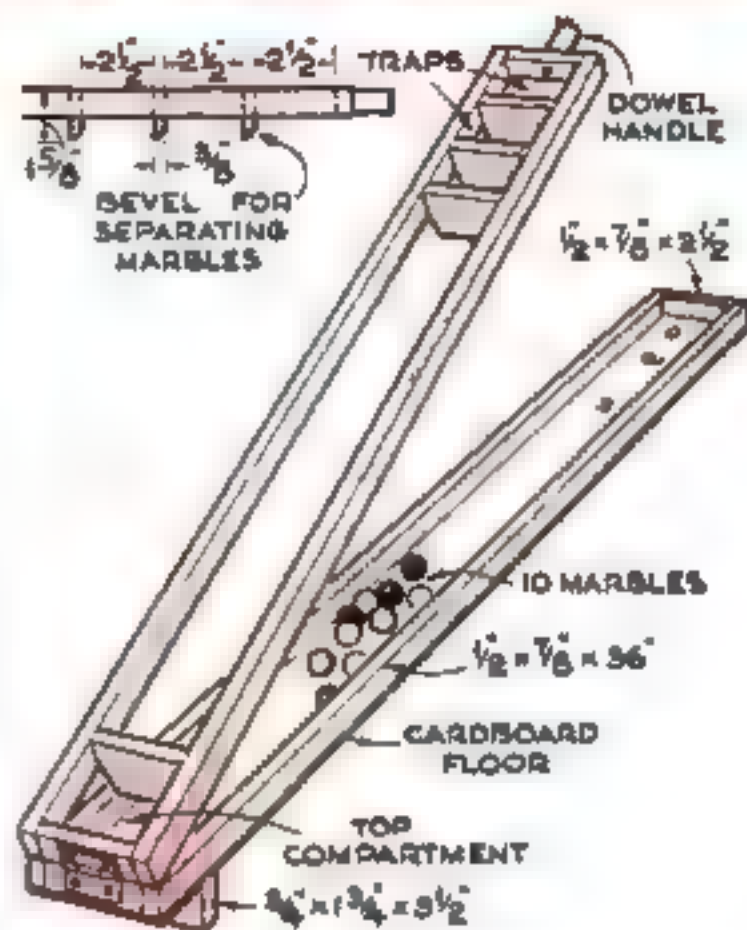
HOPPING up and down on one toe, this doll twirls a jump rope and skips realistically as she is activated by a crank or a small motor. Lay out the figure and the tree on squares, as shown. Make the two arms and two legs separately. These are pivoted on nails, which are annealed by heating red hot so they may be headed over.

The tree serves as a stationary support and also hides the mechanism. Pass the crankshaft through it and put the crankpin through the doll, as shown, hammering the end or holding it with a drop of solder so the doll won't slip off. The jump rope is wire. One end is attached to the crankshaft and the other to the hand so that it clears the toes and just misses the base. If the legs are attached as shown, one toe will just touch the base when the doll is at the lowest position. A small piece of lead, drilled and attached with a screw to the lower part of the body, will act as a weight to keep the doll from swinging too far to the front or back.

In one drawing above, the doll is shown driven by a hand crank, while the photo and drawing at the lower right show a setup for a small motor. It will be necessary, if a motor is used, to construct a set of pulleys to reduce the speed of the crankshaft to not more than 60 r.p.m., or the rope will turn too fast and the effect will be spoiled and the toy possibly damaged. These pulleys may be made from $\frac{3}{8}$ " wood stock grooved to take a good grade of fishing line. Blocks screwed to the pulleys and pulled together by two screws clamp the wheels to the shafts. A lead counterweight on the upper pulley balances the weight of the doll. If the motor is used, fasten the tree to a suitable stand.



THREE FAST-MOVING GAMES

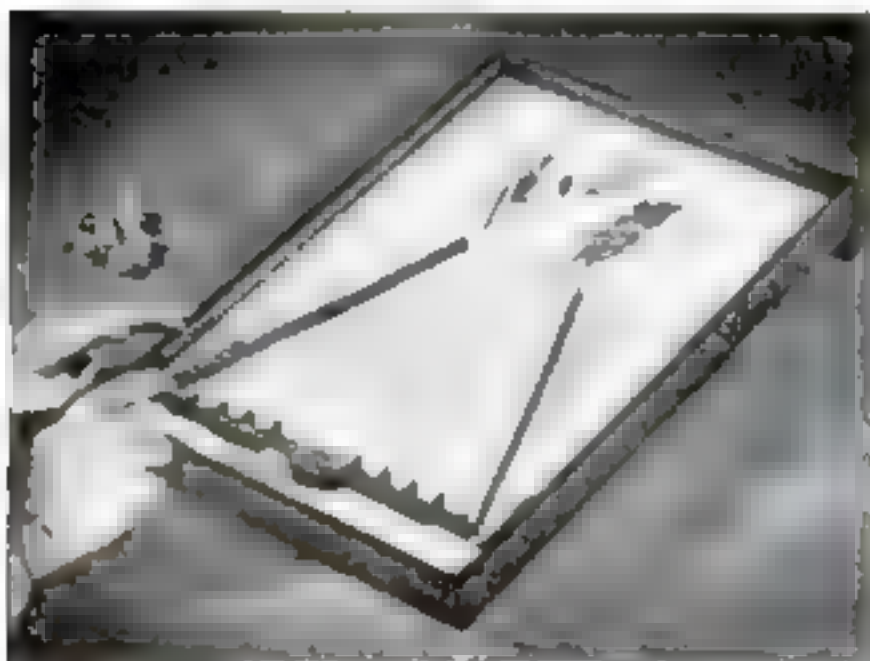


TRAPPING 'EM ALIVE calls for just the right co-ordination of eye and hand if you would score high in this game. It is played with a hinged trap that is dropped on a slanting board as 10 marbles race down.

Build the frames of wood, attach a handle and insert partitions to act as traps in the upper member, and glue or tack a cardboard base to the bottom of the lower, as shown in the drawing; then hinge the two

at one end. A short leg at the hinged end will give the board the right tilt to let the marbles roll down.

The player raises the trap section quickly to start the marbles, and drops it to catch them as they reach the scoring section. Each player gets three tries. His score is the number of marbles multiplied by the numeral on the trap in which they stop. Highest score wins.—MYRON FLEISHMAN.

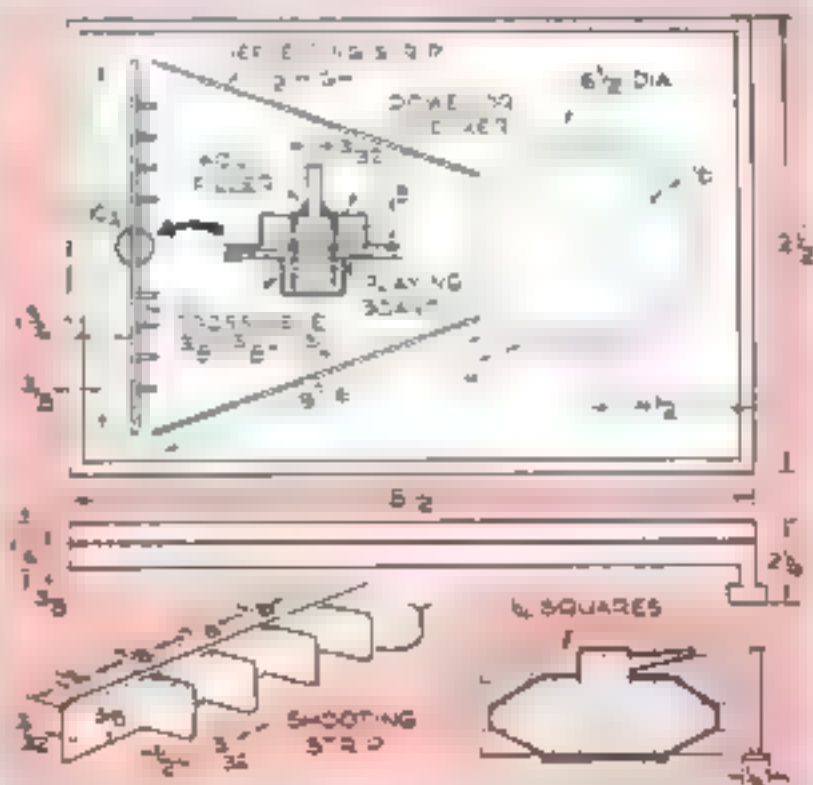


ACCURATE SHOOTING is required to knock out enemy tanks in this tank-destroyer game. A cardboard base glued to a wood frame and sloped upward toward the target forms the playing board on which the pentagonal target area is painted. Two deflecting strips are glued in place as shown.

The shooting strip, made of flexible wood and provided with pockets, is glued into a

notched dowel or checker, which is then nailed through the cardboard to a cross-piece. It is operated by flipping either end while a marble is held in a pocket.

One player sets up the tanks; the other tries to knock them out with the fewest shots. Marbles returning to the shooting strip may be shot again.—FRANK SHORE.



FOR HOLIDAY FUN

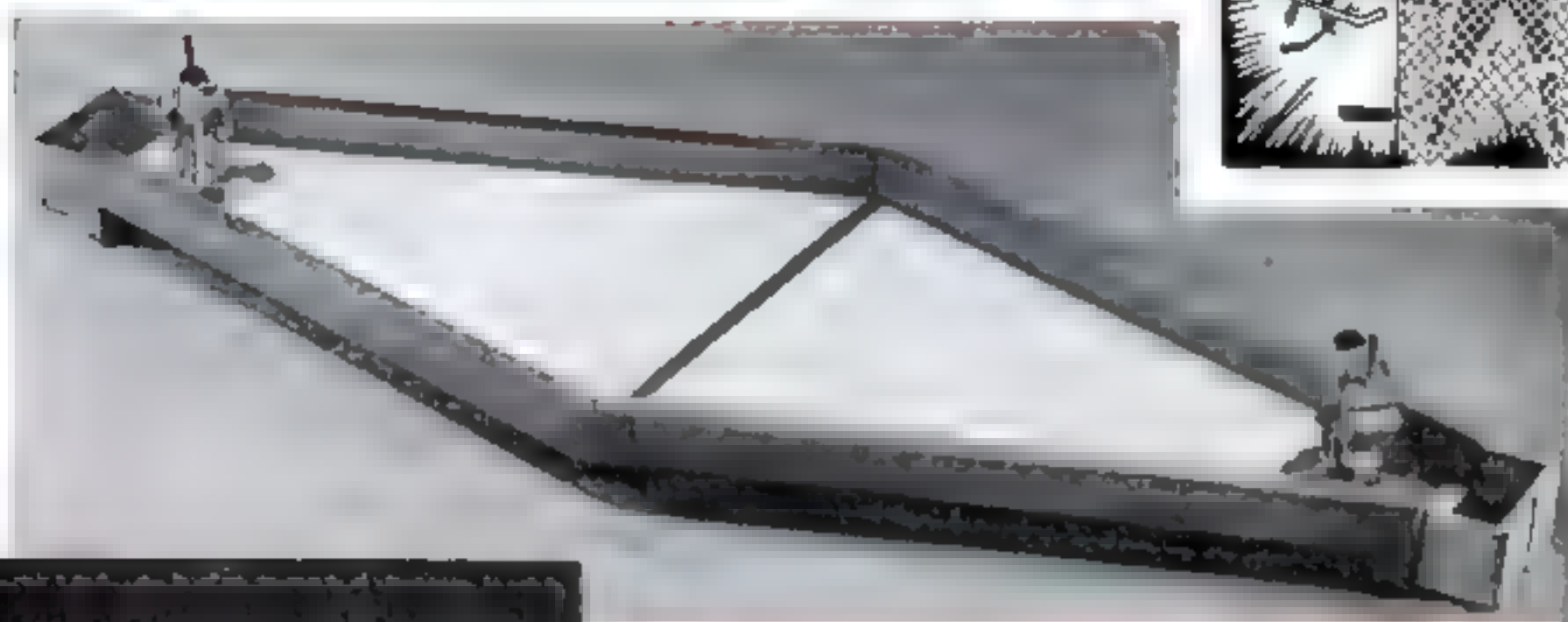
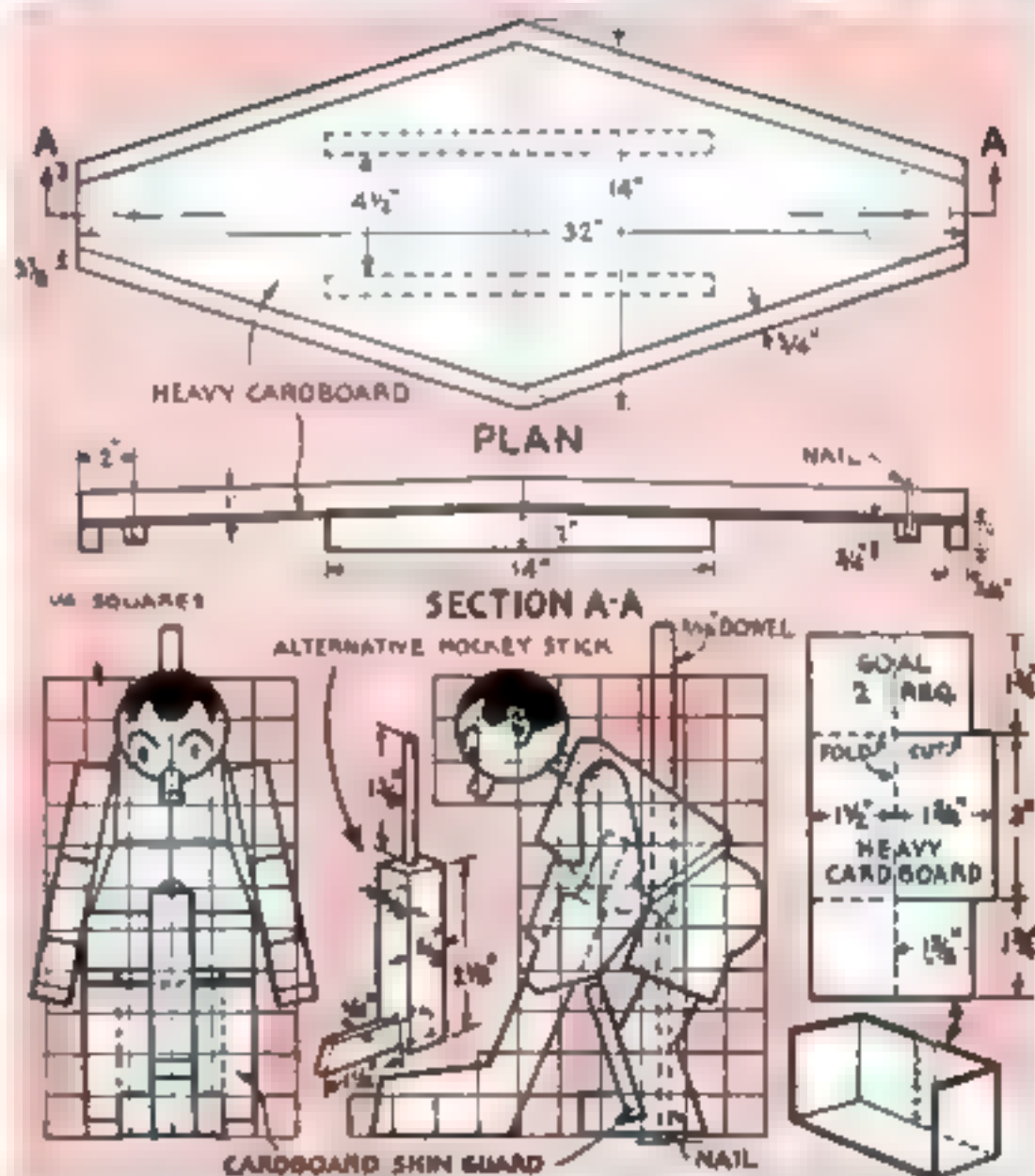


TABLE HOCKEY gives you a chance to drive the puck into your opponent's goal and to defend your own against his attack. It is filled with action and thrills.

The board is built as shown with a heavy cardboard base and wood frame. Heavy cardboard goals at the ends are removable so the puck—a steel bearing ball—can be retrieved.

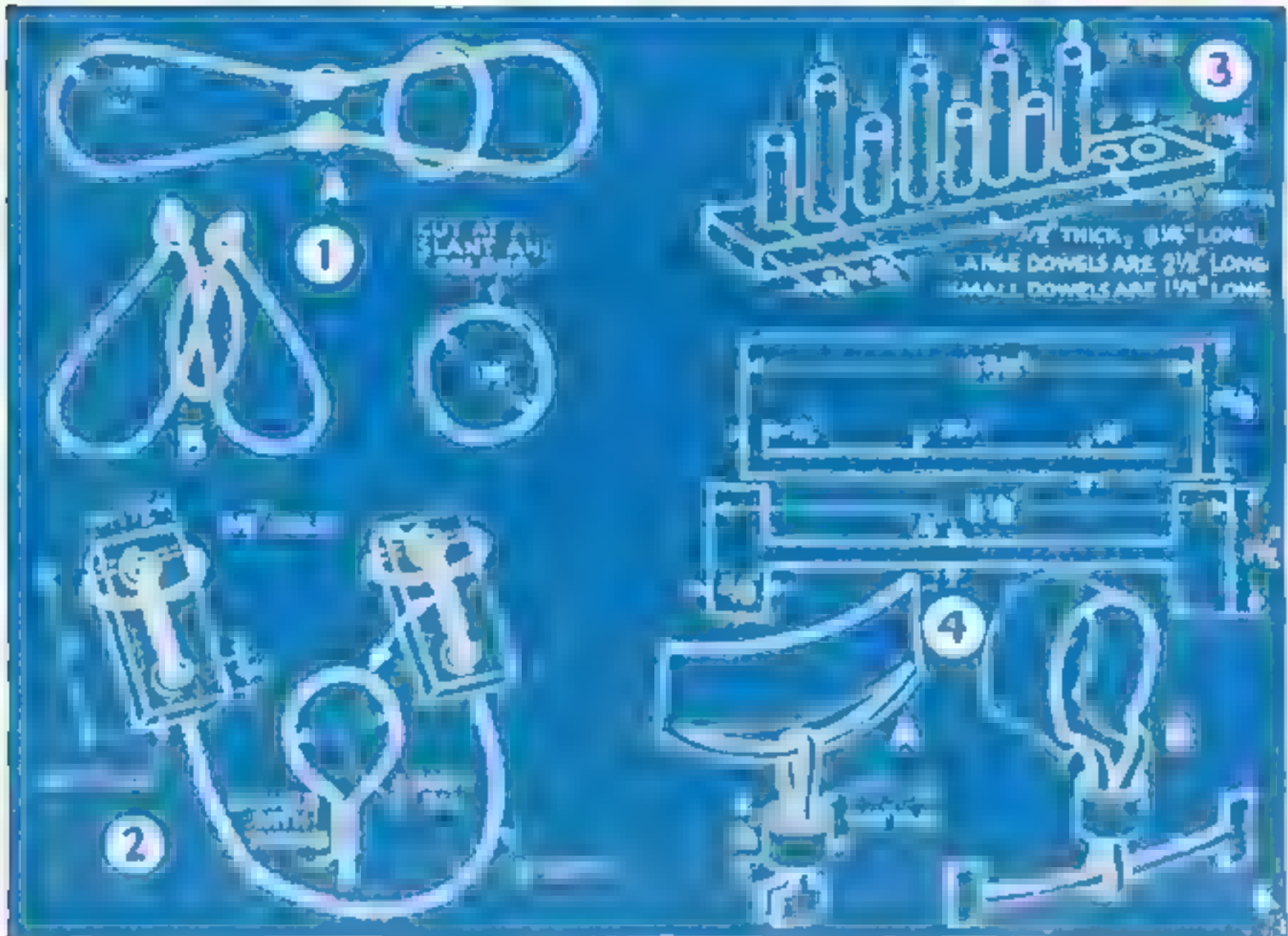
Alternative "hockey players" are shown in the photo and drawing. One is a simple block, drilled through lengthwise to swing on a pivot in the board, and counter-bored at the top to take a dowel twirler.

For those adept at carving or who have a jigsaw available, a more elaborate "player" is detailed. Drill the pivot hole and counterbore for the twirler before cutting out the figure. A large wooden bead may be used for the head if desired. Regardless of whether the carved player or the block is made, two will of course be needed.



Pivots for the players can be made from short lengths of coat-hanger wire driven tightly into holes drilled in blocks that are glued to the underside of the board.

The puck is put into play by one player and kept moving until one scores or it comes to rest beyond reach, in which case the player in whose section it rests puts it into play. When a goal is made, the player scored against starts the next play. Should a player knock the ball into his own goal, he loses the point.—C. W. E.



1 TWO HORSESHOES joined together at the ends imprison a ring in a real puzzler that will defy solution until you let your friends in on the trick. Start with the ring looped over the wire horseshoes as at A. To free the ring, twist the horseshoes sideways until two of the sides form an X as at B, work the ring over one point, pull it down as far as possible, and work it around the hump! Make the pieces from coat-hanger wire rubbed with steel wool and waxed.



By **GEORGE BARR**

3 BIG PEGS alternate with little ones in eight of the 10 holes in this board. Can you get the big ones and the little ones together in four moves, moving two adjacent ones at a time? Move 2 and 3 to the empty holes 9 and 10; move 5 and 6 to holes 2 and 3, move 8 and 9 to 5 and 6; and finally move 1 and 2 to 8 and 9! Simple, isn't it? But those who see this brain teaser for the first time will make many false starts before catching on.

2 LOOPING THE LOOP does the trick with these twin blocks of wood snared by a cord having lashed loops at both ends. It's easy, though, to free the blocks once you know how, but most of your friends will probably give up. Simply pull about 6" of cord through the holes in one block, pull the loop to the upper side, and push it down through the hole nearer the second block. Now pass this block through the first loop; then pull the loop back through the hole. You will find it is no longer around the first block, and the cord can be pulled free easily! Use a 32" length of cord.

4 HEAVY PLIABLE LEATHER and a 1/4" i.d. tube that can be made by boring a hole in a piece of 7/8" dowel are needed for a trick that dates back for centuries. The object is to free the tube from the leather when it is held in the position shown at A. Obviously the 1 1/2" projections at the ends of the narrow strap can't be forced through the 1/2" hole, but you'll be surprised to see how many of your friends will try to do that. B shows the correct method—a very simple one. Just pull the strap down through the tube along with the slit piece, and then remove the strap!

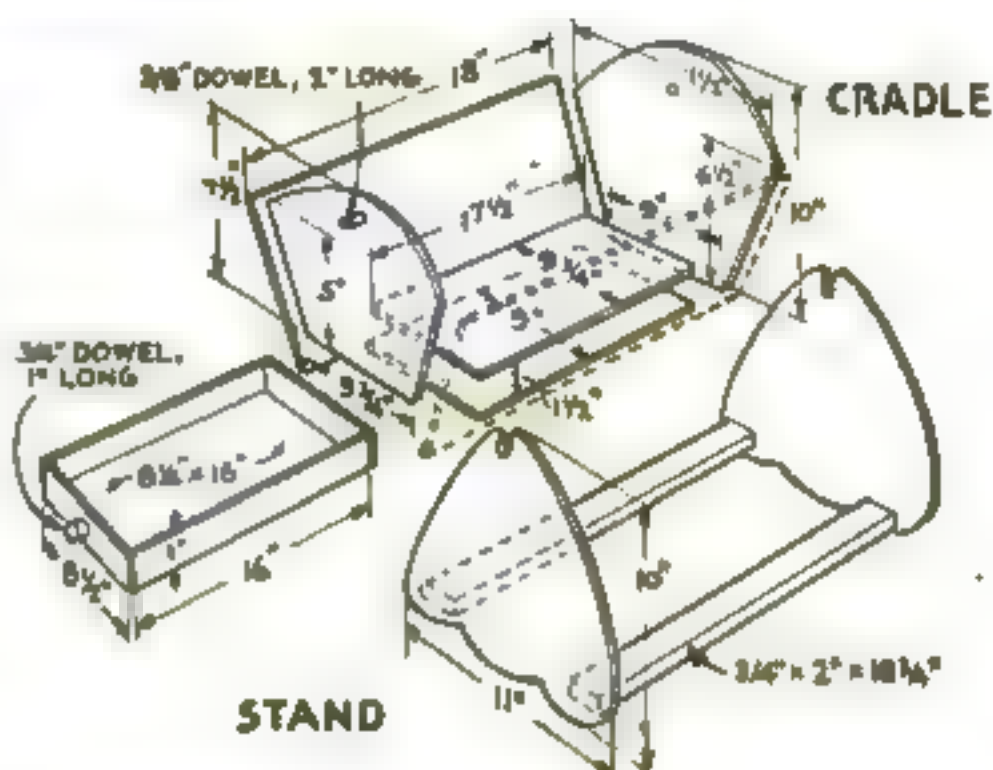
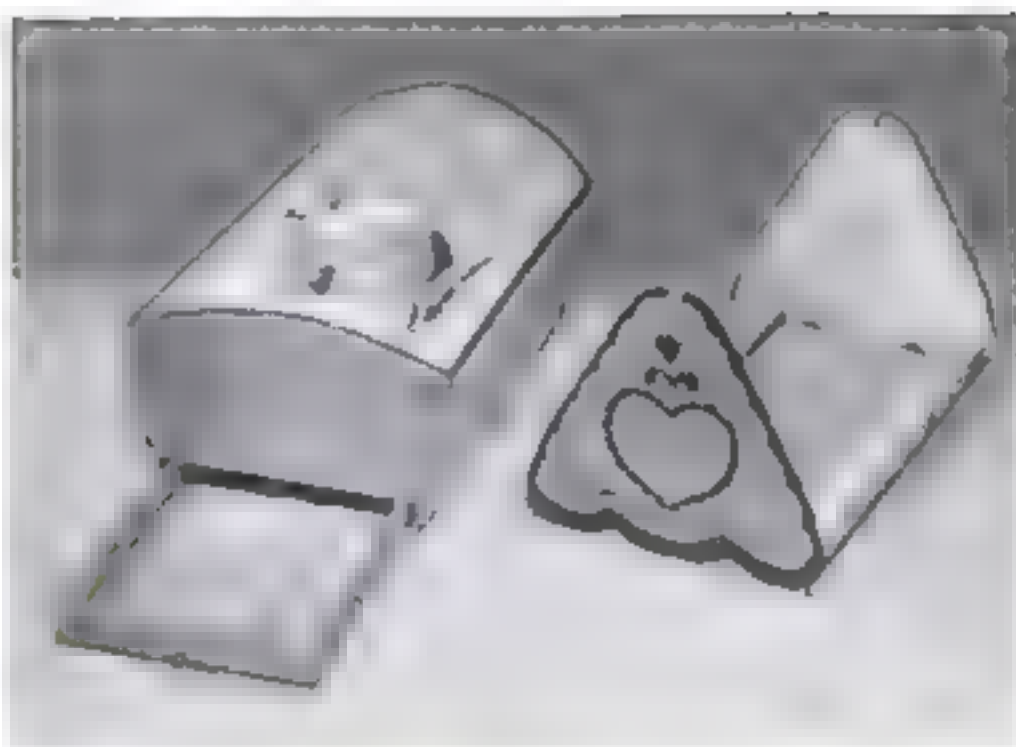


Cradle for Doll Holds Clothing in Drawer

LITTLE girls will find three ways to use this attractive peasant cradle, for it swings on a stand while the doll is being rocked to sleep, or it can be taken off the stand and used as a bed, and it also has a shallow drawer in the bottom that will hold the doll's clothes. Such a toy will delight the little girl who plays mother with her dolls.

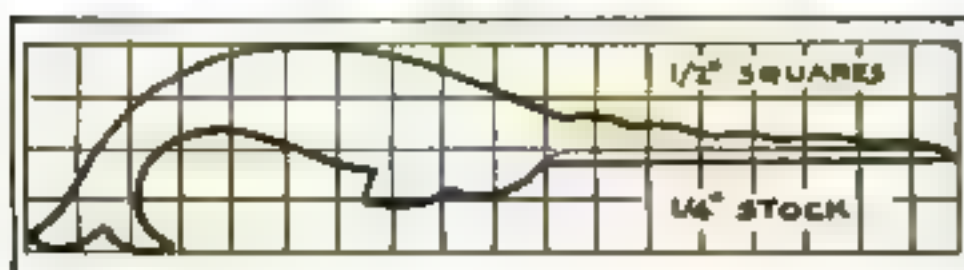
Cradle, drawer, and stand are all made from $\frac{1}{4}$ " wood with the exception of the horizontal braces on the floor of the stand, which are $\frac{3}{4}$ " stock. The dimensions are for an 18" cradle, but they may, of course, be changed to fit the size of the doll.

Notch the upright pieces of the stand to take 2" lengths of $\frac{3}{4}$ " dowel glued into the head and foot of the cradle. Holes to start the notches should be bored through both ends of the stand at the same time, and those to take the dowels should be put through the head and foot of the cradle



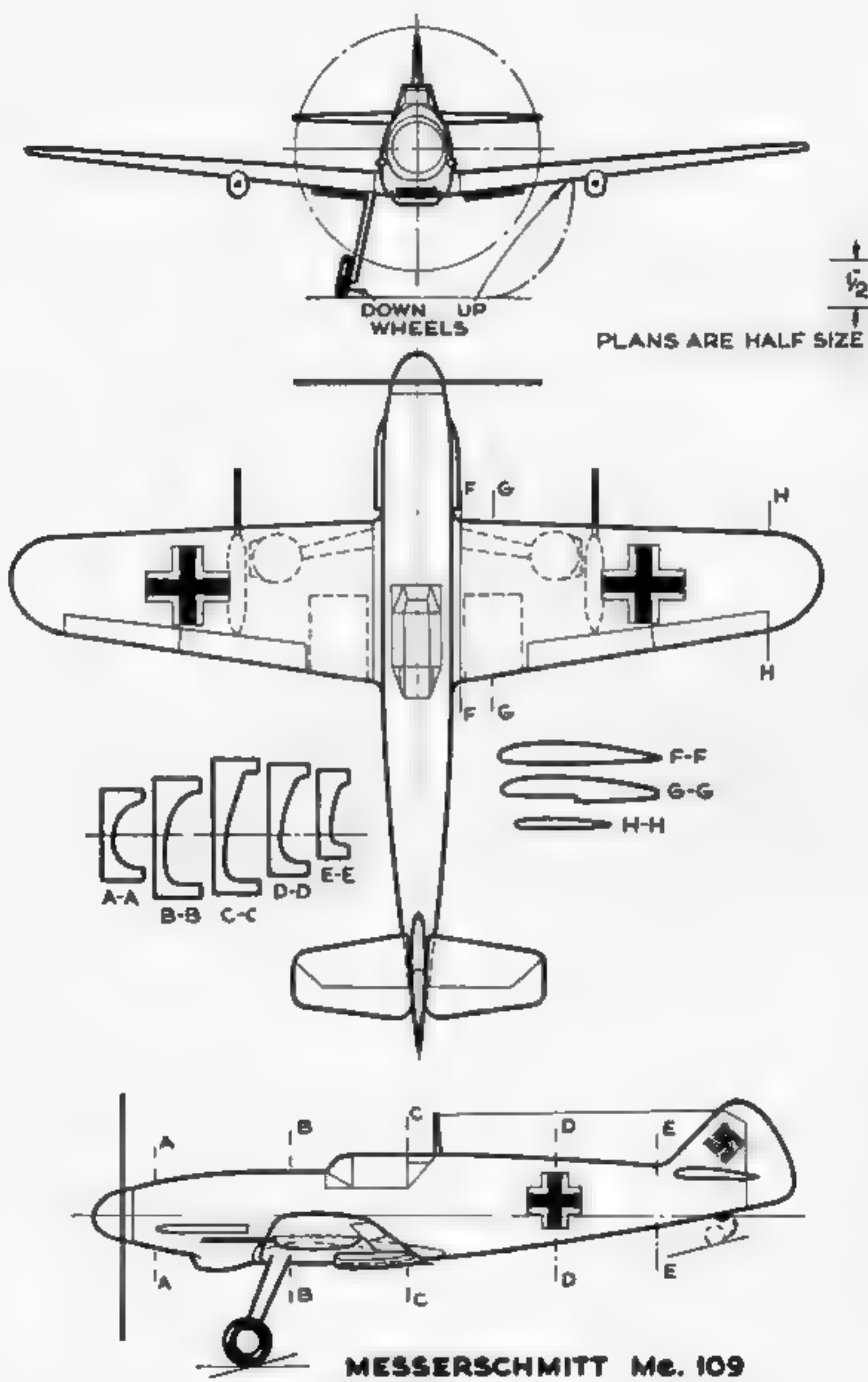
while they are clamped together. This assures having them in line so the cradle will swing freely.

When painting, remember the doll is a baby, and use appropriate pastel shades, but bright colors for the peasant decorations will add a contrast pleasing in a child's plaything. Decorations may be freehand or transfers.—E. W.



Swordfish Letter Opener Cut from Nicely Grained Wood

MAHOGANY, walnut, or other hardwood with a grain that will take a nice finish is suitable for this attractive letter opener. Use either $\frac{3}{16}$ " or $\frac{1}{4}$ " stock. Lay out the swordfish design on squares and saw the outline with a coping saw or jigsaw; then bevel the lower edge of the sword with a rasp so it will cut paper. Simple carving may suggest an eye and mouth. Finish with sandpaper and two coats of varnish. The original paper knife was a project of a boy of Junior Achievement, New York.



Me. 109G . . . FAMED NAZI FIGHTER

THE Messerschmitt Me. 109—renowned Luftwaffe fighter—is the German counterpart of the English Spitfire. It is powered with a liquid-cooled in-line Daimler-Benz engine of about 1,200 hp., which gives a maximum speed of nearly 375 m.p.h. and a rate of climb in excess of 3,000 feet per minute. Extremely maneuverable, it is at its best at high altitudes, where it is employed for interceptor purposes. The first 109 was used years ago in the Spanish Civil War. Since then it has gone through many changes, culminating in the 109G.

This model makes an attractive modern addition to your home or office. Together with planes already described, it is ideal for use in aircraft-identification classes because students learn the important identification points in three-dimensional form, rather than from a comparatively unreal flat orthographic drawing.

Construction closely follows that of the other models in this series (see, for example, P.S.M., Sept. '44, p. 158); so only those points that are especially unique and applicable to the Messerschmitt are given here.

The two wing panels are made in one piece, then cut apart and glued or cemented to the fuselage. They are held firmly in place by boring a hole through the fuselage and running a dowel through the hole so the ends stick out about $\frac{1}{2}$ " on each side, then sharpening these ends and forcing the wing panels onto the points. Make the fillets around the wing-panel roots from wood putty or a mix of talcum and dope.



Readily apparent in this picture is the graceful fuselage line of the Messerschmitt. Plane spotters use such characteristics for recognition purposes.

Paint the top surfaces of the completed model a dull greenish brown and the undersides a light blue. Finish the cockpit in white and add the details with black India ink and a ruling pen. The propeller is a celluloid disk. The stand may be bought from a model-supply house or made up from a simple turning and a piece of dowel.

Useful Bench Clamp Is Made From Hardwood and Scrap Material

THIS bench clamp is simple to make and easy to use. Since it is mounted on the bench top, work can be uniformly supported throughout its length. Thus in some cases it is better to use the clamp than a conventional vise, which allows the ends of long work to sag. A notch in the wedge is for clamping material more than 1" thick. The wedge and one of the stationary pieces are faced with leather, as indicated, to prevent marring delicate work. Make the three pieces from hardwood, taking particular care when cutting the bevel. Fasten the wedge to the bench with a leather thong so it won't be misplaced and firmly secure the other two pieces in place with flathead, countersunk wood screws. Try several locations before mounting the clamp.—F. LYTKEN.

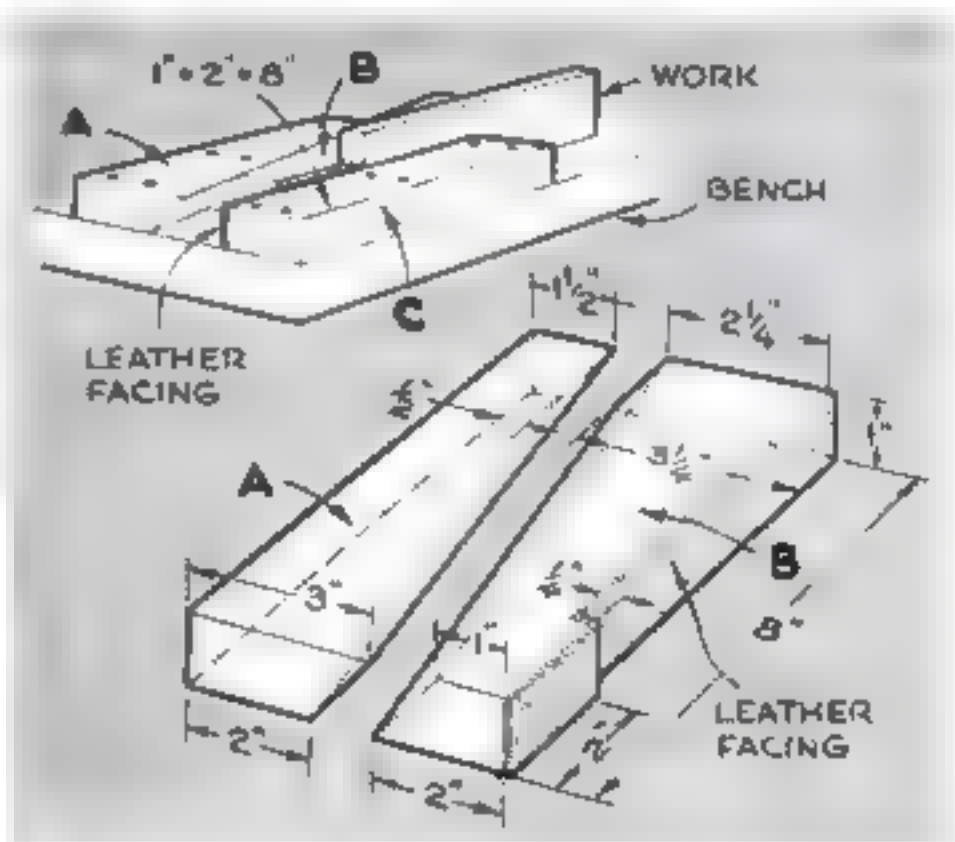




TABLE TRICKS

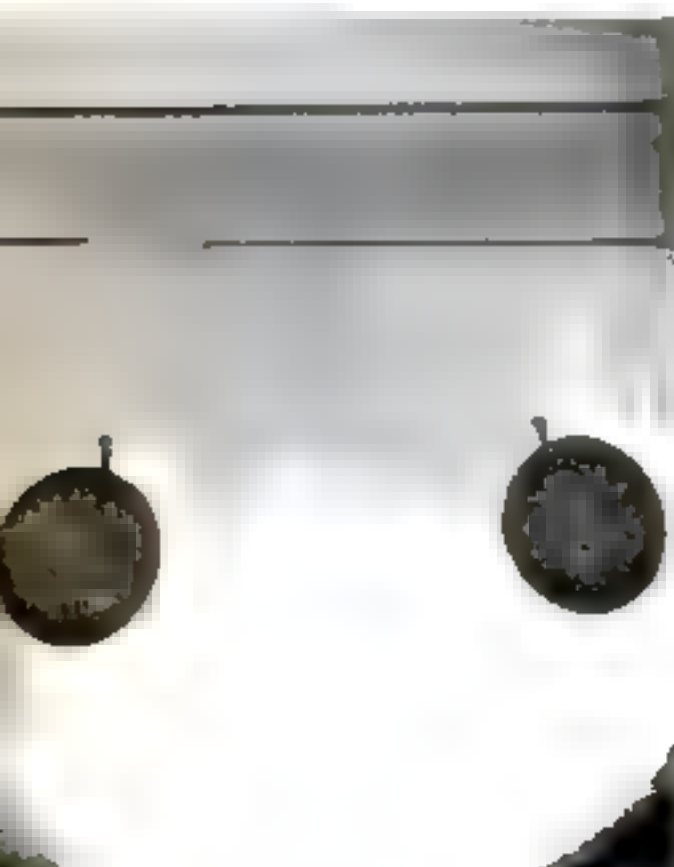
WHAT BRAND DO YOU PICK? Even if you don't smoke, you can do this trick. Have several of your friends lend you a cigarette, each a different brand. Then blindfold yourself and have the cigarettes passed to you by an assistant who calls the name of each as he hands it over and you drop it into a bowl. Stir them around to mix them; then have your assistant call out the brand of one. You can pick it unerringly from the bowl despite your blindfold! How? It's really simple. Prearrange with your assistant the brand he will ask you to pick, and when he hands that cigarette to you, squeeze it just enough so that you can tell it later by feel.

YOU CAN READ MINDS by putting two cards from a deck in your pocket surreptitiously. Take three more from the deck and have a friend select one mentally. Put the three in your pocket, remove the two already there, and return them to the deck without showing the faces, saying that you now have in your pocket the selected card. Have your friend name his card, and produce it for him! You have, of course, memorized the order of the three held.

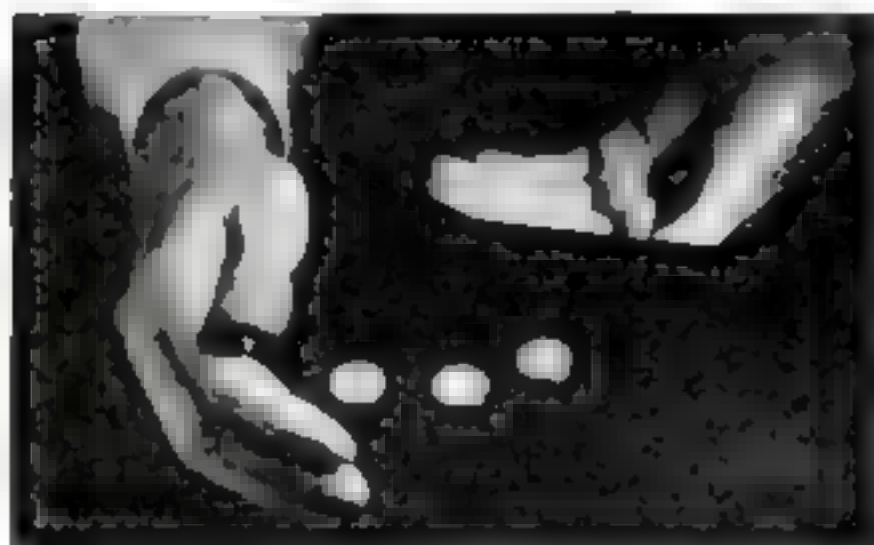
MAGIC BALLOONS OBEY COMMANDS given after a few gestures that may be recognized by science students but will mystify others. The gestures consist of rubbing your woolen coat sleeve a few times on one or both of the balloons. If you rub both, they receive the same electrical charge and repel each other; if you rub only one, they stick together. The trick works best on a dry winter day.



NAMING A COIN placed under a cup while your back is turned is easy if you have an assistant to work with you. He simply turns the handle in a prearranged direction—right, left, toward you, or away from you—to indicate the denomination of the coin! The trick may be worked even more subtly and effectively by having the different positions of the handle vary only slightly, such as pointing to different articles of tableware or to figures in the design of the tablecloth. Don't repeat the trick too often.



A SODA-POP CANNON that goes off with a bang and recoils like a real gun will amuse your friends after dinner. Pour half an inch or so of vinegar in a soda bottle and lay it across two round pencils that form the gun carriage. Wrap half a teaspoonful of bicarbonate of soda (baking soda) in a piece of a paper napkin for a charge and insert it in the neck where tilting will slide it into the vinegar. Then put in a cork medium tight. Jolt the charge into the vinegar and hold your breath! As the vinegar soaks through the paper, carbon dioxide gas is generated, and in a few seconds the cork will fly out with a loud report, while the recoil will cause the bottle to roll back realistically on the pencils.



ONE WAY TO MAKE MONEY is to make four coins appear where there were only three before. You need a table without a cloth and—yes, four coins! Put three coins in view on the table, show your empty hands, and then brush the coins off while holding one hand under the edge to catch them. This hand will come up with four coins to the surprise of your friends if you are adept in loosening the fourth coin from under the edge of the table where it has been stuck with a dab of soap or gum.



YOU CAN PICK A MARKED COIN from a hat with your back turned and without ever seeing it! Place half a dozen coins of the same denomination on the table, have someone mark one while your back is turned, and let him pass it around so all in the group may inspect it. How can you tell it without looking? Simply by its change in temperature! Handling by your friends will make it warmer than the other coins. If the room temperature is normal, the difference can be detected very quickly.

LET YOUR FRIENDS in on this one—for a time! Hold a handkerchief by opposite ends, drop one end, and stroke it briskly several times. Now grasp the lower end and let the other go—and the handkerchief will stand upright. Many of your friends will be able to do likewise. But they can't imitate you when your handkerchief stands out horizontally or when it bends backward and forward as you beckon—unless, like you, they have a length of piano wire hidden in the hem!





STURDY TOYS BUILT WITH HAND TOOLS

By HI SIBLEY

YOU can make it an old-fashioned Christmas this year for your own children or those of a friend with these durable, all-wood toys designed for construction with ordinary hand tools. The hobbyhorse, standing 30" high on its rockers and fashioned after the kind grandfather rode when he was a boy, will bring joy to any modern youngster. Pulled by a 12" engine, the pioneer train is an equally pleasing toy. You can build as many passenger cars or box-cars as you wish to go with the engine and tender, and there is a caboose to trail along if your train is to be a freight.

Saw out the horse from white pine or some other soft wood, cutting the three pieces for the body first from $\frac{3}{4}$ " and $1\frac{1}{2}$ " stock 8" wide, as shown at A in the drawings below. Rough them to shape with a handsaw, as at B; then screw and glue

the pieces together and shape them, as at C, with a drawknife, plane, rasp, and sandpaper, rounding all edges. The notch in the middle piece is to receive the neck.

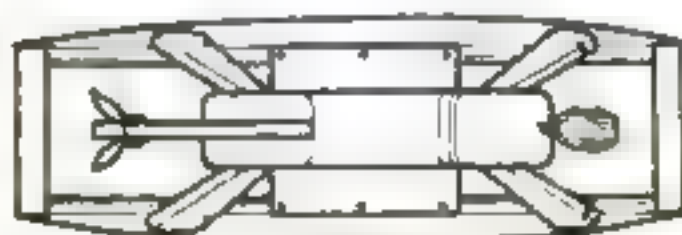
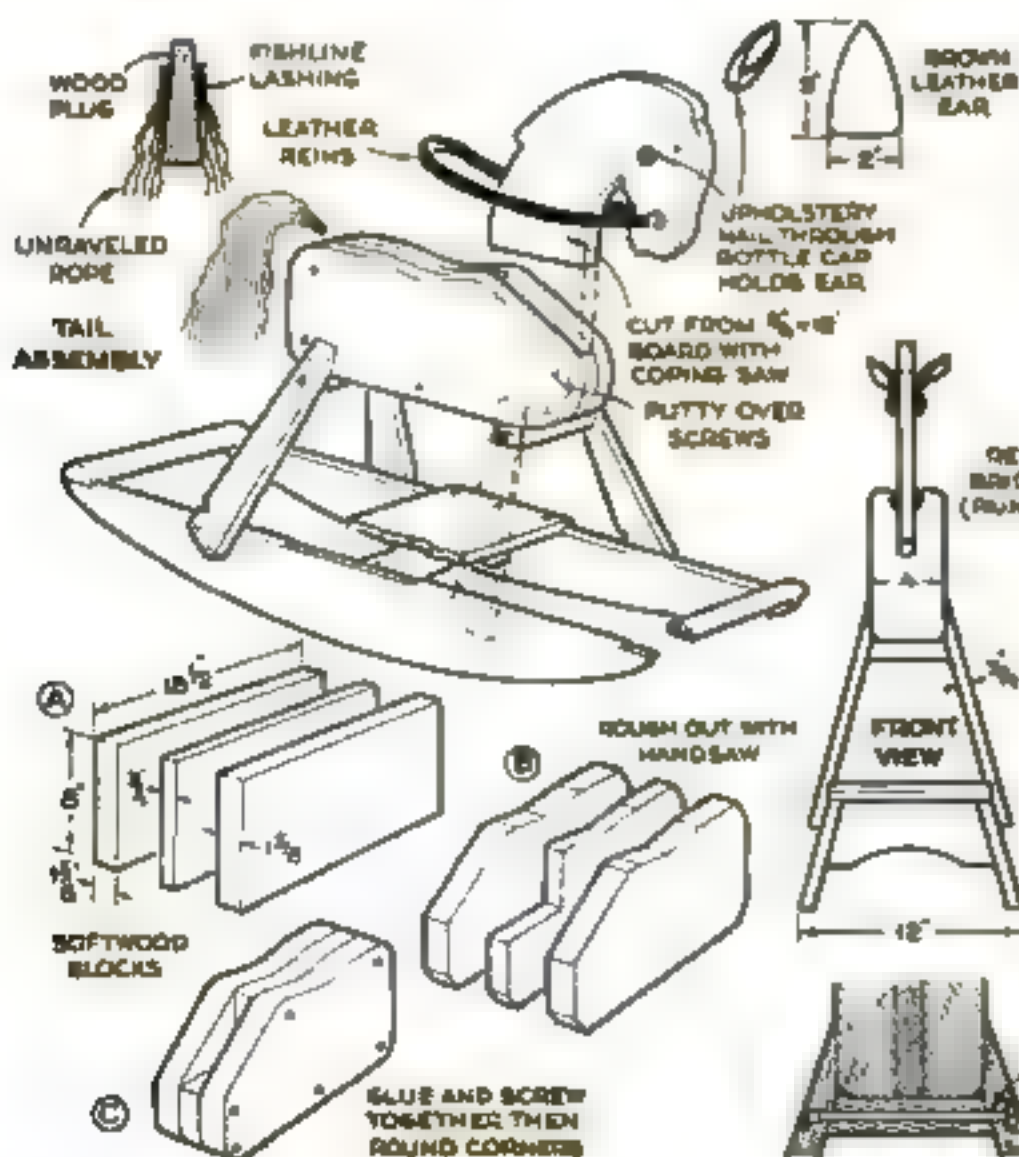
Lay out the head and neck on squares, as shown, cut them out with a coping saw, and assemble the piece in its notch. The legs are beveled at the upper end, screwed on the body, and reinforced with a long $\frac{1}{4}$ " bolt put through them and the supporting blocks. An unraveled length of rope, bound around a peg and glued and driven into a hole in the body, forms the tail.

The rockers are cut from 7" boards with a coping saw or a compass saw. Bevel the bottom edges so they rest evenly on the floor. After the painting has been completed, attach each leather ear with an upholstery nail driven through a bottle cap; then paint the bottle caps.

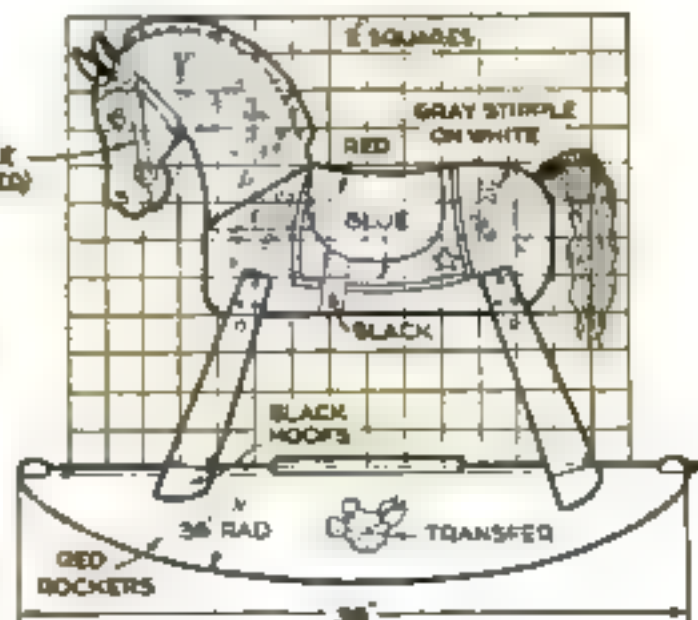
The train can also be made without power tools, in spite of the round boiler, smoke-stack, steam dome, and wheels. Use soft wood, as with the hobbyhorse, for easy working. Shape the boiler with a drawknife and plane, checking it with a template as you proceed; then bore and notch it for its

attachments, as shown in the drawing on the facing page. The other rounded pieces are easily carved or shaped with a

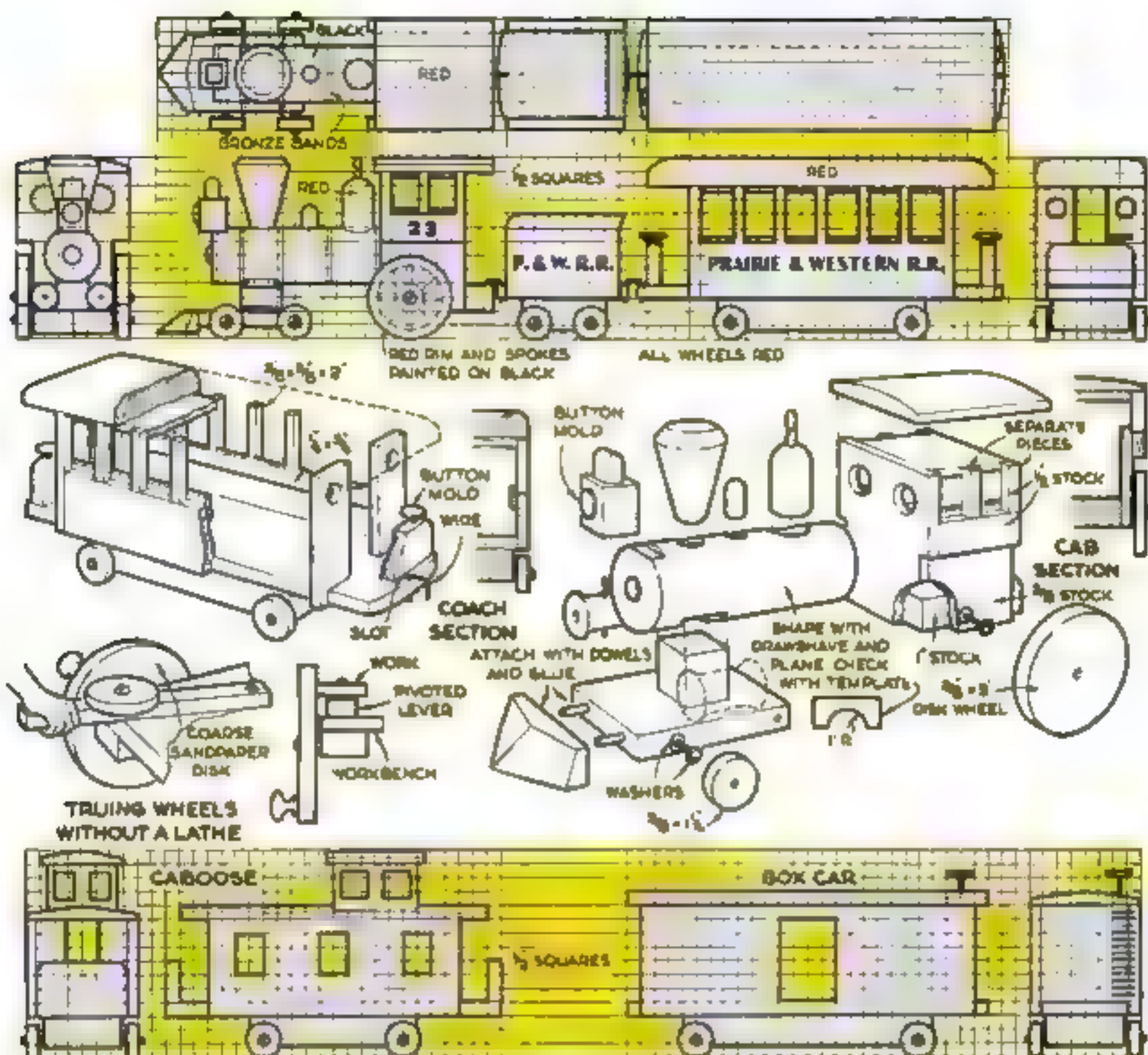
Christmas



TOP VIEW



CARRIAGE BOLT THROUGH LEG



rasp and sanded. Cut out the drive wheels with a coping saw. They can be trued up on a hand-turned sanding disk, as shown in the drawing. The spokes are simply painted on. Small wheels can be sawed from a broom handle or a piece of $1\frac{1}{4}$ " dowel.

Much work is avoided by building up the cab and coaches from small pieces, as indi-

cated, so you won't have to cut out the windows. In this construction, the uprights framing the windows fit against an inside strip that forms a shoulder. Boxcars and a caboose are built up just as simply.

Be sure to round the ends of all platforms so the train can take curves easily. Slots are provided in them for wire couplings.

Broken Christmas Tree Ornaments Make New Sparkling Decorations

ALMOST every Christmas, when you unpack your fragile, shiny tree ornaments, you probably find one or more broken beyond repair. You can make interesting new ornaments by crushing the glasslike material very fine and sprinkling it on circles, stars, and other shapes cut from heavy paper or cardboard and coated lightly with thin glue. Scintillating variegated effects are possible if you mix several colors, or you can keep the colors separated if you prefer.—B. N.

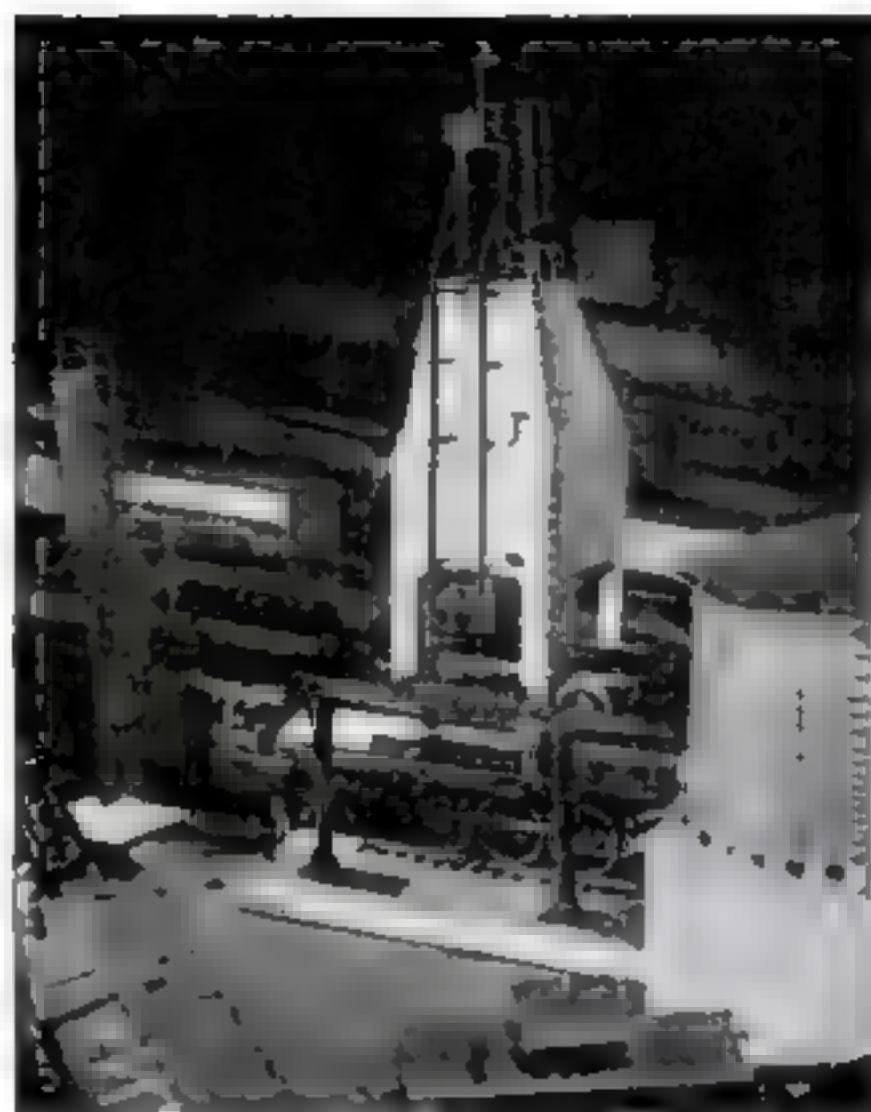
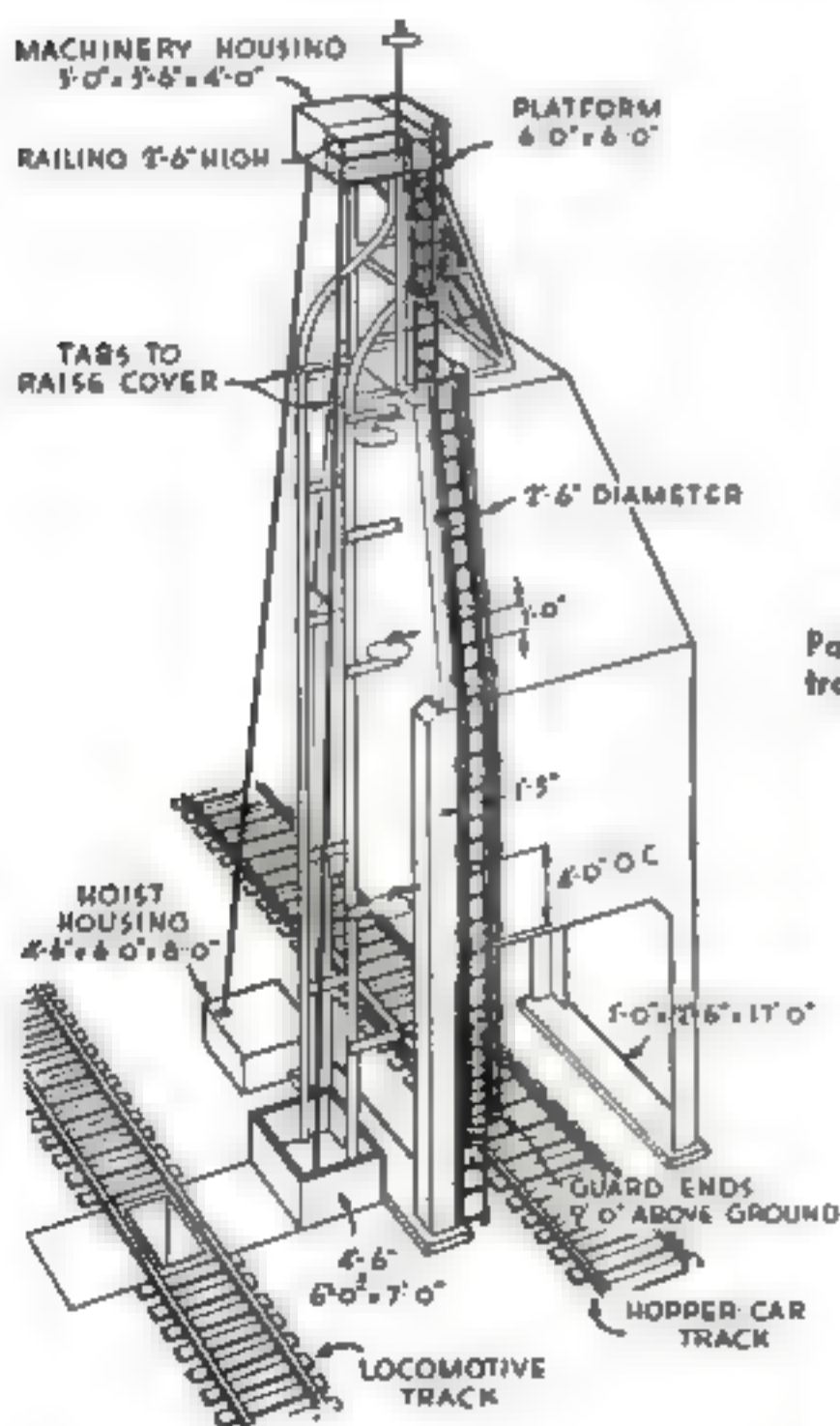


CINDER POCKET FOR YOUR MODEL RAILROAD

By William Schopp

THIS cinder-disposal plant will add a touch of realism to your model-railroad layout. Such a plant is a familiar sight in actual railroading. Coal-fired locomotives drop their ashes into the cinder pit and a skip hauls them to the top and dumps them into the pocket. When it is full, a gondola is run under it and the accumulated ashes are dropped into the car and hauled away.

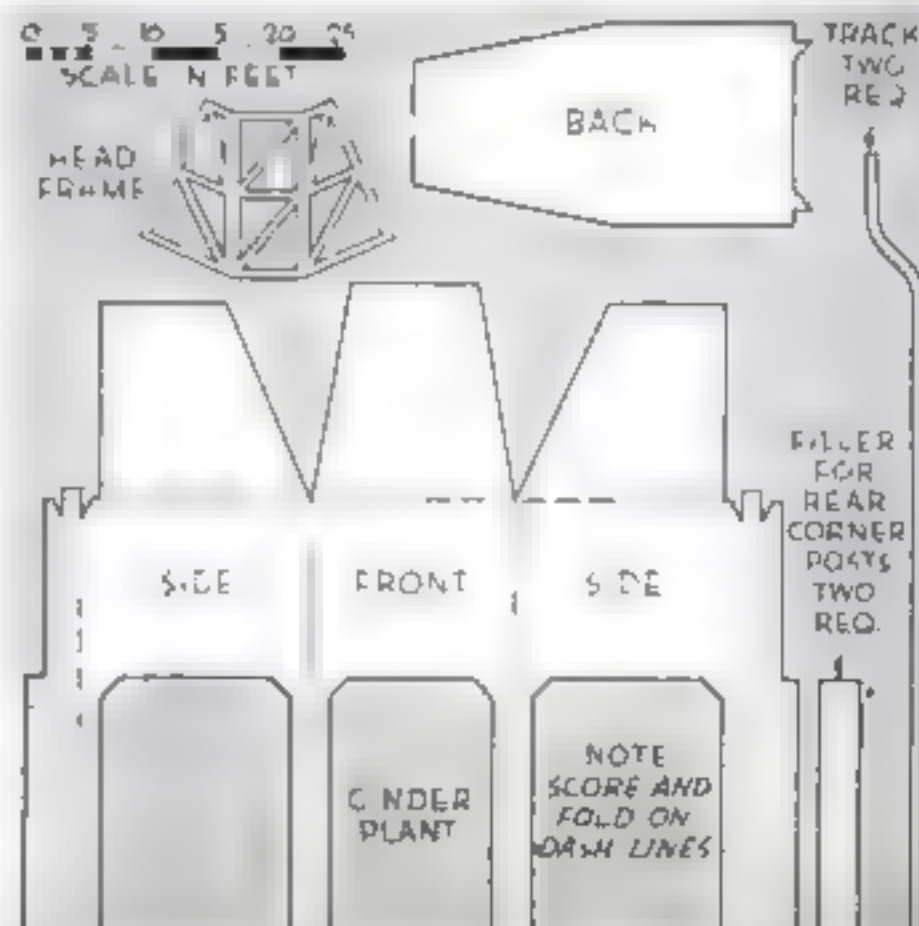
All dimensions given are for the full-size prototype. They should be scaled to suit the scale of your layout. Draw the patterns for the pocket, the head frame, and the skip tracks on heavy Bristol board, cut them out, score and fold them on the dotted lines, and glue them together. Note that the top of the pocket is made in two pieces—a U-shaped stationary part and a rectangular

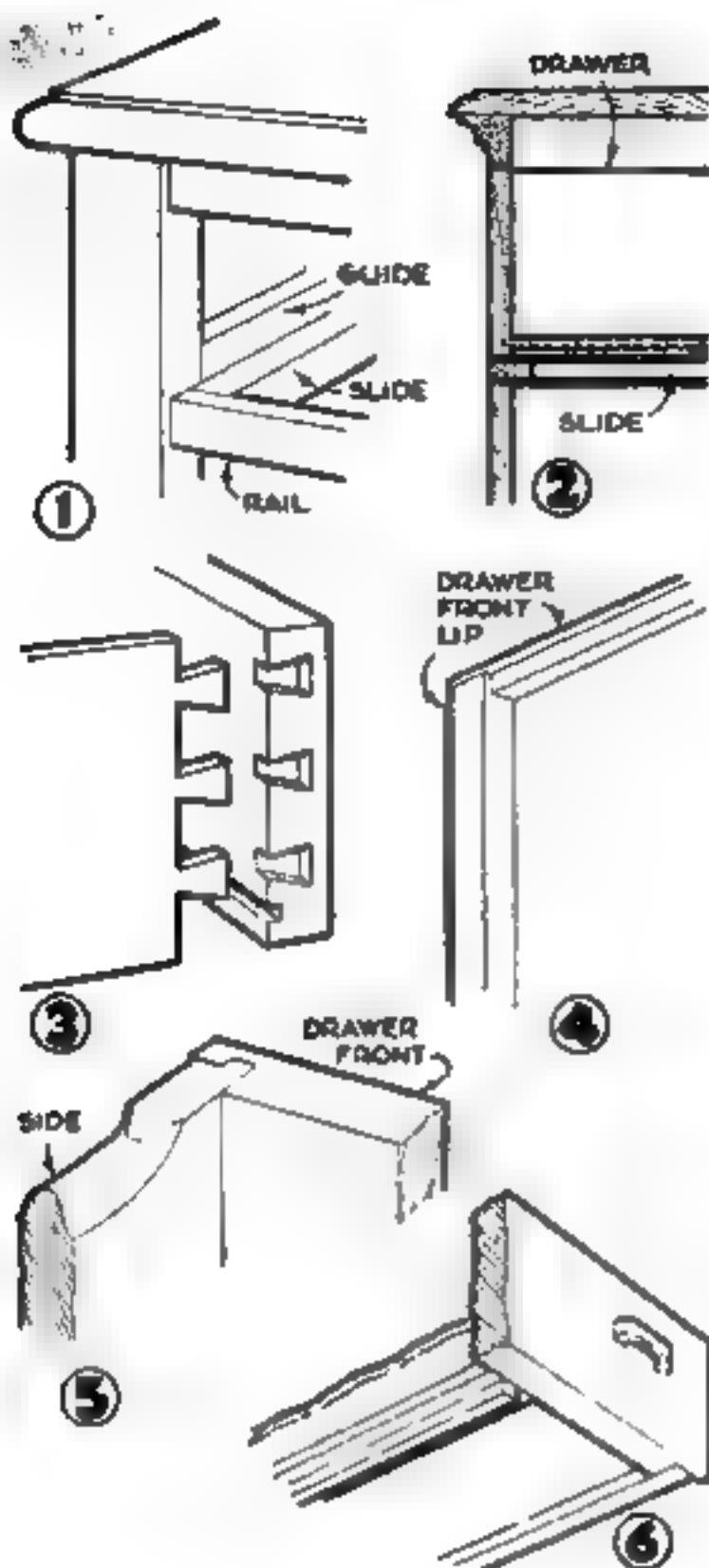


Unpainted Bristol board here looks like concrete hinged cover that lies within the head frame and has two lifting tabs. The skip tracks are 5' apart and are supported by 4' brackets. They, as well as the cinder-pocket foundations, the skip well, the hoist housing, the machinery housing, and the platform are also made from Bristol board.

Pieces of wire, cut to length, bent to shape, and soldered together, form the platform rail and the safety ladder. Disks of Bristol board with gooseneck-shaped wire supports and glass-bead bulbs simulate lights. The skip cable is a piece of cord. It is anchored at each end and runs up and over bent pins under the machinery housing.

Patterns for the pocket, the head frame, and the skip tracks are given below. Make them from Bristol board





What's Wrong?

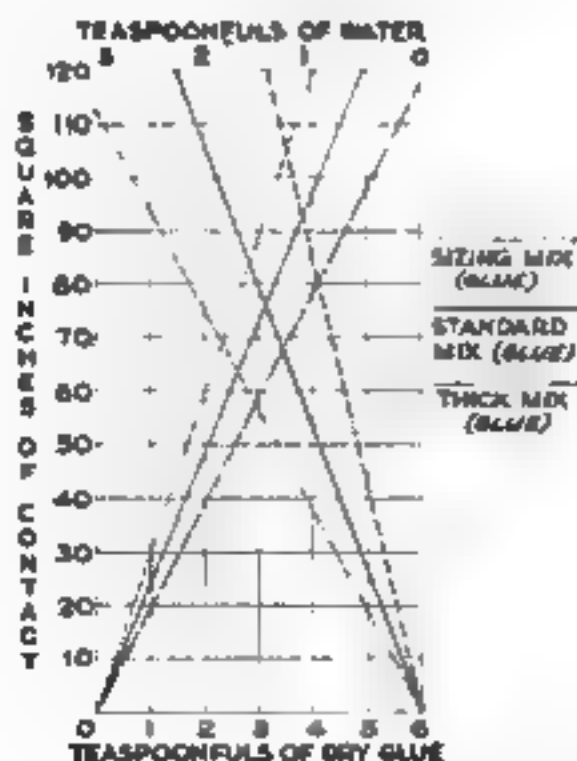
DRAWERS are not hard to build, but if you follow directions in the drawings here you will have trouble. Can you find seven errors in construction shown in the six drawings? After you have answered, turn the page to check with the correct answers given upside down below.

1. Two errors are shown here. The top of the drawer slide should be raised about 1/16" above the rail to keep the sides from wearing grooves in the rail, while the guide should project inward to prevent wear on the cabinet post.
2. With no hold-down slide above the top drawer, the front will drop when the drawer is more than half open.
3. Dovetails should be so proportioned that the lower tail will cover the end of the groove made in the drawer front to receive the bottom.
4. With the end rabbet deeper than the upper rabbet, the ends of the drawer will always seem to be open even when the top is tightly closed.
5. Tenons should be made on the drawer front and mortises on the sides; otherwise the pieces may be pulled apart.
6. Rilled slides and guides, when used, should be built into the cabinet, not on the drawers, for the projection would keep a drawer from entering its opening.

ANSWERS

PLASTIC GLUING GUIDE

[WOODWORKING]



This chart shows the amounts of dry glue and water required for sizing standard and thick plastic glue mixtures for areas up to 120 sq in. For larger areas, multiply the reading proportionally.

Use the chart this way. How much standard-mixture glue is needed for joining two 1" boards 5' long? Since dressed 1" stock measures 3/4", the area of the joint, that is, the area of one of the joined surfaces, will be 3/4" multiplied by 60" or 52 1/2 sq in. Find 52 1/2 sq in. on the vertical scale and follow it horizontally to its intersection with the standard-mix line that begins in the lower left corner then drop to the glue scale at the bottom which shows 2 2/3 teaspoonfuls of dry glue are needed.

How much water? Follow the same horizontal line to its intersection with the standard mix line that begins in the lower right corner then read up to the water scale at the top where the water needed is shown to be 1 teaspoonful.

Use standard kitchen measuring spoons and cups. Dip loose glue and scrape it off level with the edges. Dip water.

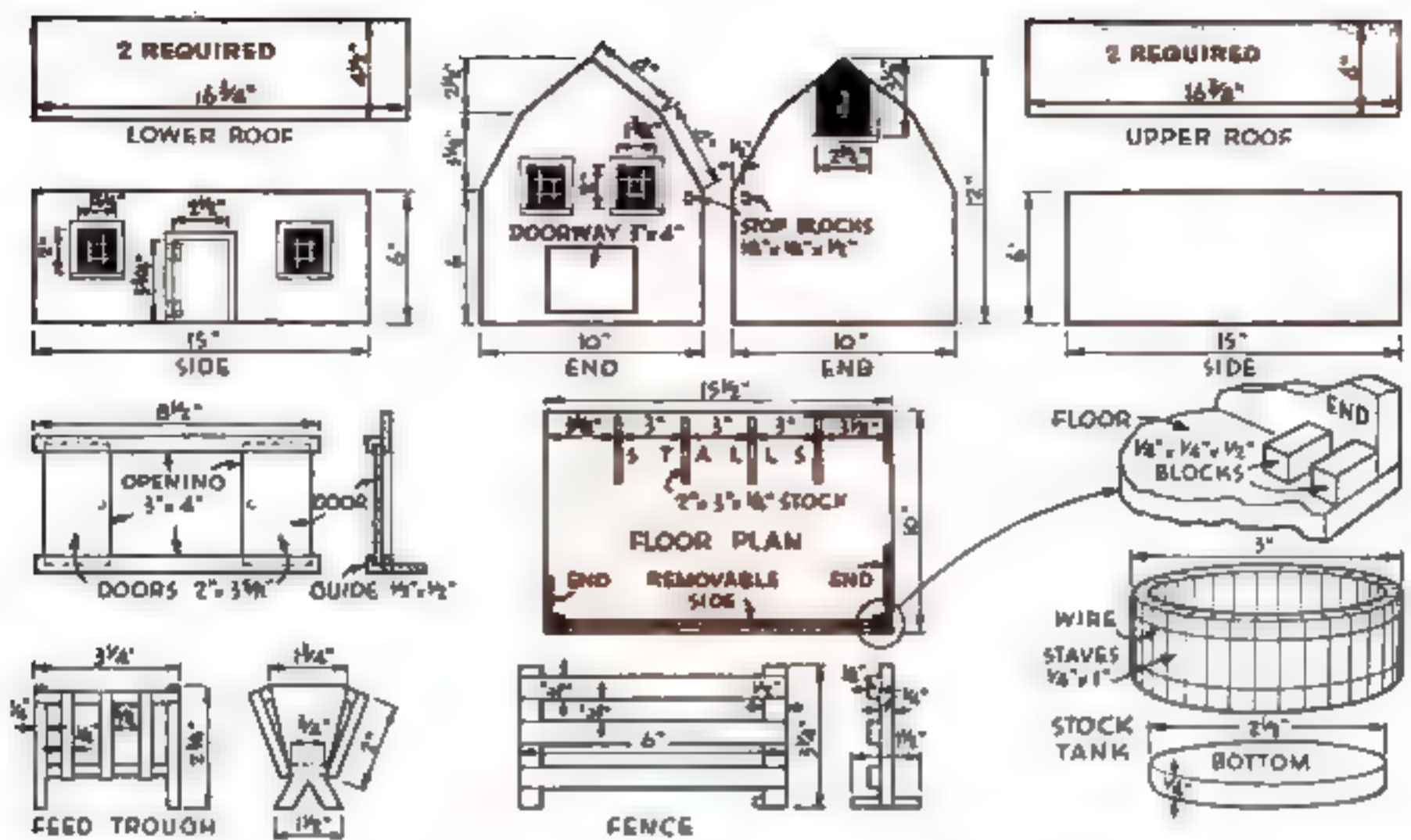
11 level teaspoonfuls equal 1 oz. dry glue

13 1/2 " " " " 1/4 cup

7 1/2 teaspoonfuls dipped water equal 1 oz.

13 " " " " 1/4 cup dipped

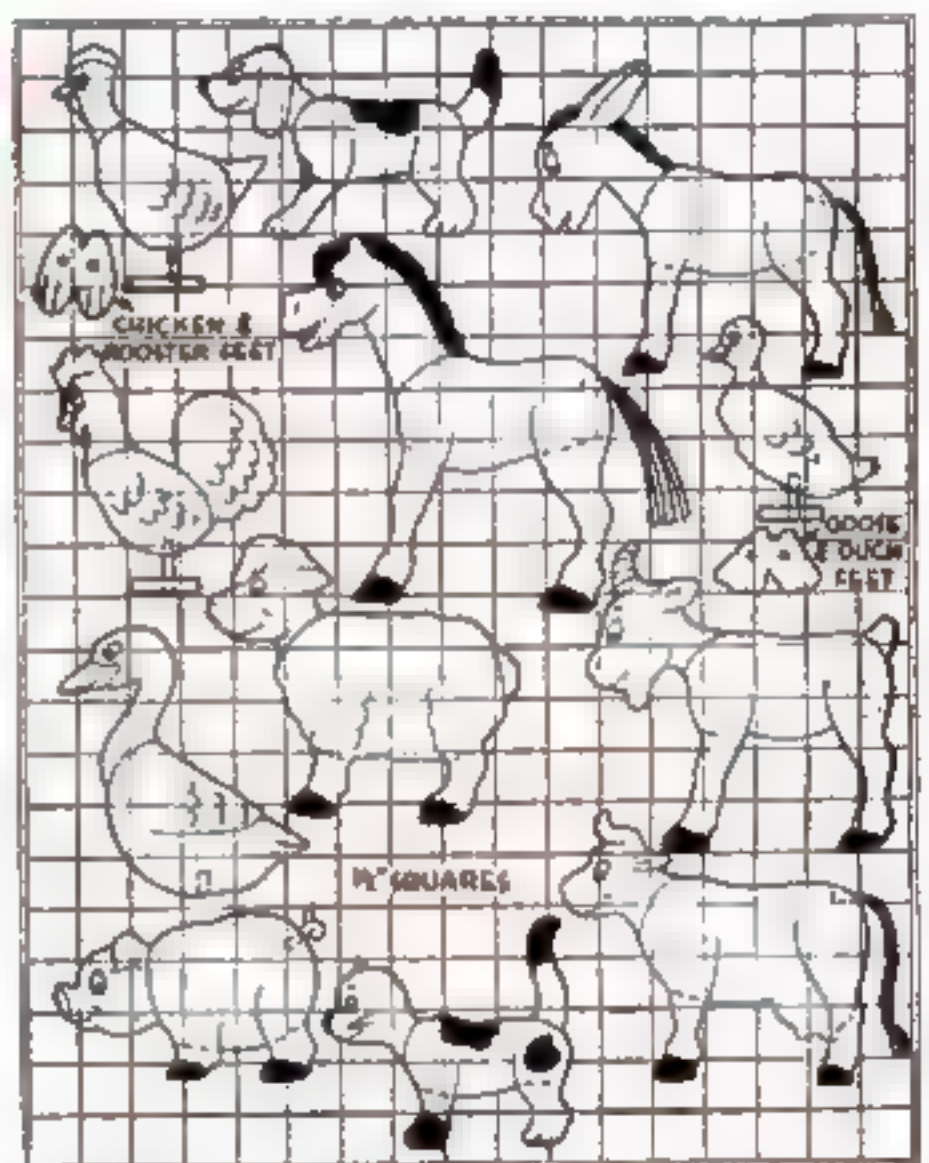
POPULAR SCIENCE MONTHLY SHOP DATA



Toy Barn for the Young Farmer

SCRAP pieces of $\frac{1}{4}$ " plywood or solid stock will serve for this toy barn, its accessories, and livestock, and will make a welcome Christmas toy. All joints should be nailed and glued so they will stand the rough usage children usually give their playthings.

The removable left side of the barn may be taken out altogether or slid up into the roof to be held by blocks nailed inside the front and back. Normally it is set in catch blocks nailed to the floor at the two ends. Strips of roofing material lapped over each other give the realistic shingle effect to the barn shown. A haymow may be installed by adding a board under the roof over the stall



section. The doors open on hinges or on slides, but the windows are merely painted in, though they may be cut out if you wish.

All animals are of three thicknesses. Lay them out on squares on one piece and nail this to two others, putting the nails through scrap material, so the three parts may be sawed at one time. Then saw the legs off the middle section and the head and tail off the sidepieces. Cord may be used for tails where suitable. After the pieces have been painted and dried, add features with India ink.—ELMA WALTNER

How to Re-Cover a Canoe

RE-COVERING a canoe, a periodical chore ever since canvas replaced birch bark, has been greatly simplified in modern times by the evolution of a procedure that can be mastered easily by the amateur. One of the leading exponents of this method was the late Dan Beard. The job is best done in winter when the canoe need not be put to immediate use.

Turn the hull upside down and carefully remove all the outside trim, including the keel, the stem and stern facing pieces, the rubbing strips, and the gunwale moldings. Then strip off the old canvas, being sure to remove all the tacks.

Examine the hull carefully for rot, since all rotted pieces must be taken out and replaced with sound material if you would avoid future trouble. Should the stem or stern post be bad, use the piece as a pattern for cutting or steam-bending a new member of oak or ash. Sand down all new work, and also sand old work where necessary, taking care to smooth off all protrusions that might injure the new covering or prevent it from fitting smoothly and snugly.

Use No. 10 seamless cotton canvas for a canoe up to 16' long and No. 8 for one longer than 16'. The length of the covering should be 3' longer than the over-all length of the boat, and the width 8" greater than the amidships girth. One piece is preferable, but if there are stem and stern facing pieces and

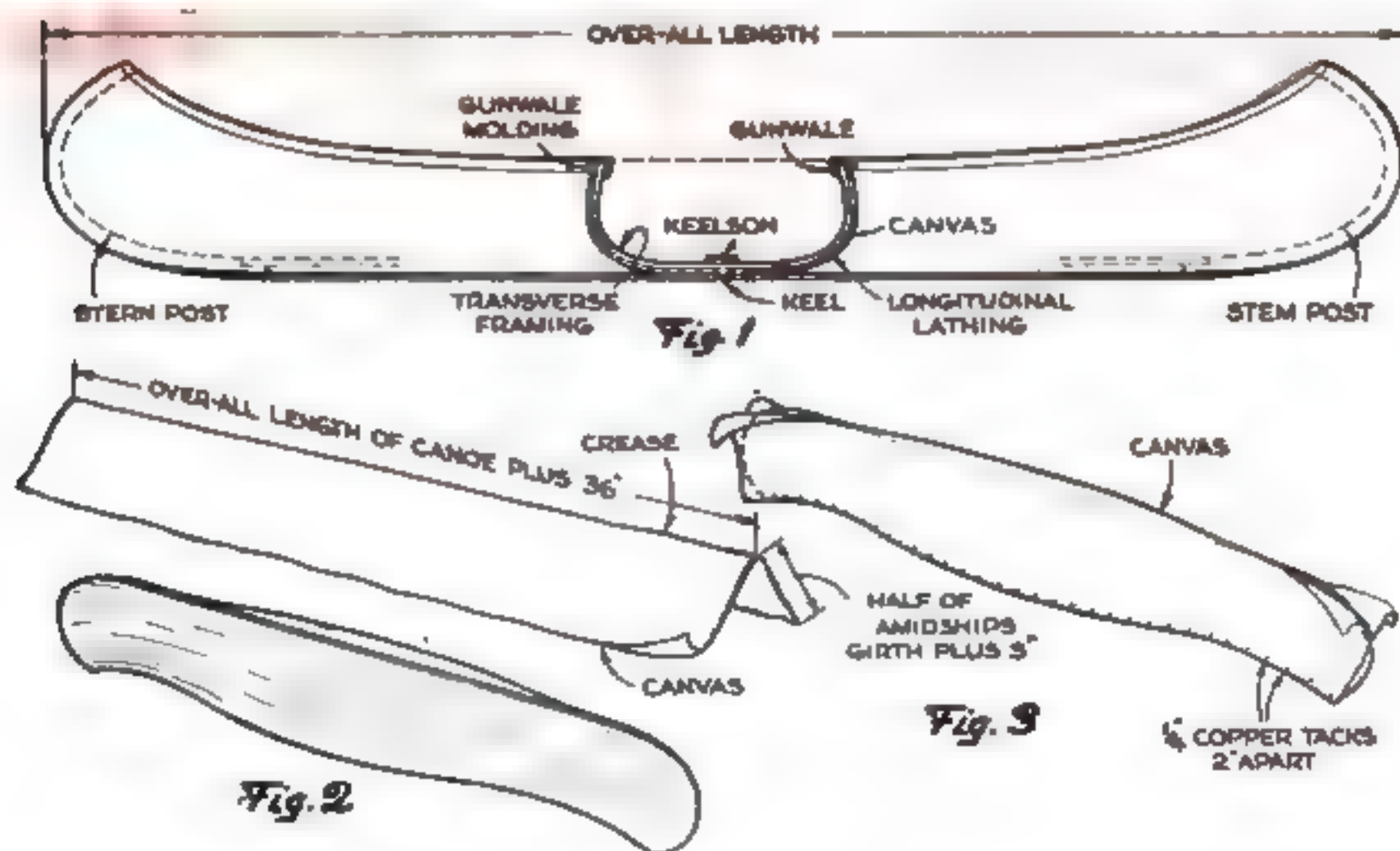


a keel that will cover a seam, two widths may be sewed together.

Fold the canvas lengthwise to find its exact center and crease it. Lay it evenly over the length of the canoe with the crease along the center of the keelson, and then, with the help of an assistant, pull it as taut as possible from stem to stern, using four $\frac{1}{4}$ " copper tacks driven in part way to hold it lightly to the keelson between the stem and stern posts.

Now, beginning amidships, pull the cloth taut on one side and drive tacks lightly along the gunwale about 2" apart for a space of about 2'. Move to the other side and repeat the operation, tacking the canvas for about 3'. Then, alternating from side to side and working and kneading the cloth with your hands and fingers to prevent wrinkling, tack the covering to the gunwales for the entire length.

This leaves the canvas stretched tightly on every part of the hull except at the bow and stern, where it will be loose over the curved posts. Slit the cloth here with shears, cutting along the center to within $\frac{1}{2}$ " of



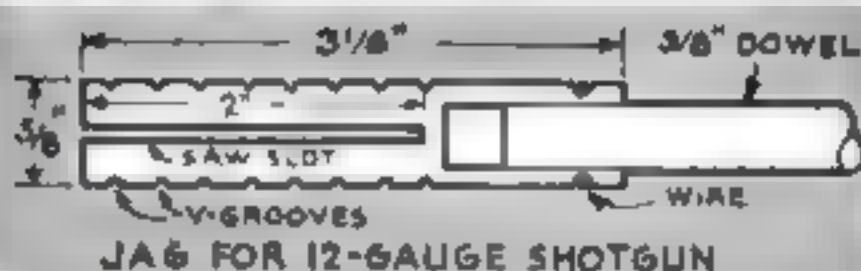
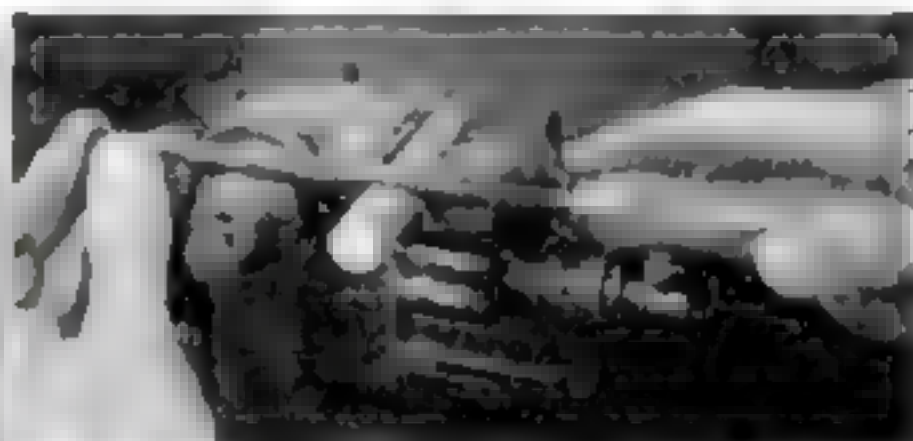
the stem and stern-post joints with the keelson. Then pull the right-hand flap tightly over the left side and glue it to the stem post, using marine glue heated in a double boiler and applying it with a paintbrush. Cut away the surplus canvas; then pull the left-hand flap and glue and trim it. Repeat this at the stern.

Examine the covering for wrinkles and remove and reset tacks to smooth them out; then drive all tacks home and add additional tacks every 2" along the keelson. Trim off

excess material at the gunwales and pour hot water all over the canvas to shrink out any puckers.

When the canoe has dried, give it a sizing coat of white lead thinned with boiled linseed oil, putting the paint on generously along the keelson and gunwales. Finish with two coats of canoe enamel, sanded between coats. Replace the trim, setting it in white lead and fastening it with new screws. If the fastening holes are worn so they won't hold the screws, fill them with wood putty.

Detachable Jag Is Used on Homemade Shotgun Cleaning Rod



FOR a convenient jag to hold a strip of wool on the end of a cleaning rod, shape a $3\frac{1}{8}$ " length of maple dowel with a series of annular grooves cut with a three-cornered file, as shown above. Then slot the piece to hold the ends of the cloth and to permit the two halves to spring together as the jag is pushed into the choked portion of a gun bore. The grooves keep the wool from slipping, while the wire in the end groove prevents splitting of the wood. Embed the wire ends in a recess.

Dimensions for the jag shown are for one for use with a 12-gauge shotgun. They should be changed, of course, for a gun of different bore. If this is too small for drilling the end hole to fit snugly on a length of $\frac{5}{16}$ " maple dowel that serves as a cleaning

rod, reduce the end of the rod to $\frac{5}{16}$ " or $\frac{1}{4}$ ". A detachable handle may be made from a file handle or a piece of broomstick. Make all joints snug so some force will be required to pull them apart. Should they wear and become loose, a layer or two of paper or thin cloth will restore the fit. Lacquer or varnish will help preserve the wood.

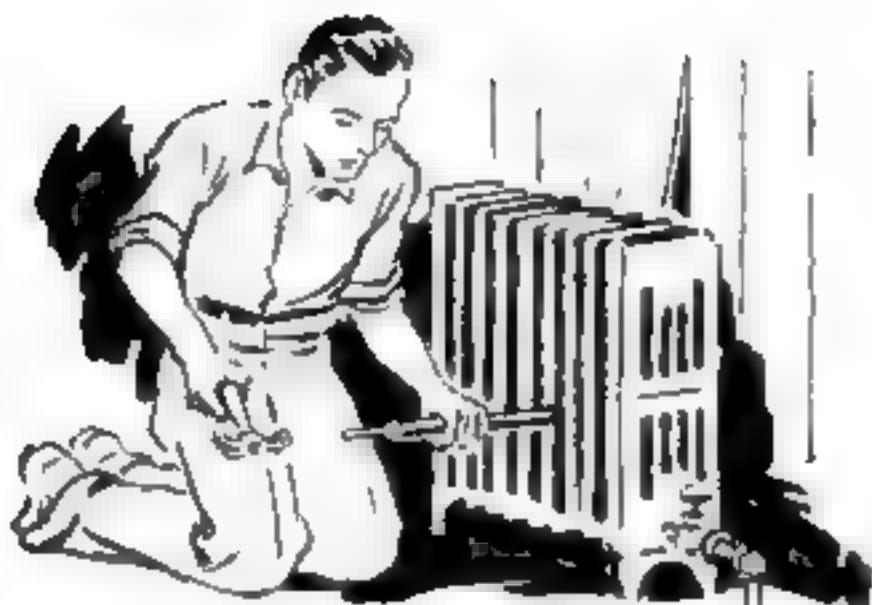
Another useful attachment for the rod is a mop made of sheepskin glued, woolly side out, on a wooden core. A firm bore polisher for use with a polishing compound can be made by gluing felt washers of the proper diameter on wood. Standard gun-cleaning tools having threaded studs can be fitted to the rod with a brass adapter. Drill one end the diameter of the rod and drill and thread the other for the stud.—W. E. B.

Handy Emergency Candle and Fire Lighter from Shotgun Shell

STARTING a campfire with wet kindling can be a cold, hard chore. The task is easier if a candle or similar fire lighter is at hand. A good one can be made by holding a piece of heavy, soft cotton twine upright in an empty shotgun shell and pouring wax around it. To use it, peel away a fraction

of an inch of the paper shell at a time so as to expose a little of the wax.

When not needed, the fire lighter can be carried in one of the shell loops of a hunting vest or coat. It can also be used as an emergency candle, for the brass end acts as a secure and convenient base.—JOHN KRILL.



Nails Driven Behind Radiator with Aid of Tube and Rod

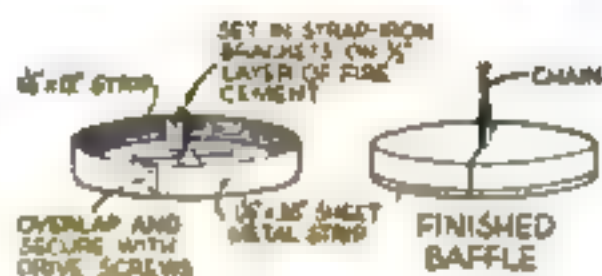
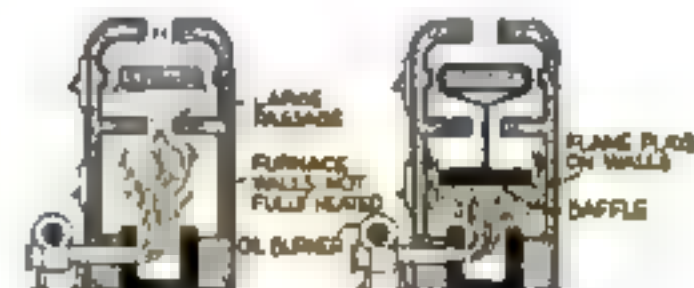
WHEN boarding or wallboard has worked loose behind a radiator, or heat-reflector sheets are being installed, nails can be driven in firmly without disconnecting the radiator if they are slipped into a short piece of pipe and backed with a solid rod. The rod should be slightly longer than the tube so the head of the nail can be driven in flush with the board, and the diameter should be such that the rod will slide easily in the pipe but will not permit the head of the nail to pass and become jammed.

Insert the tube between radiator sections and use a hammer on the rod. The method will be convenient for driving nails in many tight corners.—H. D. CHAPMAN.

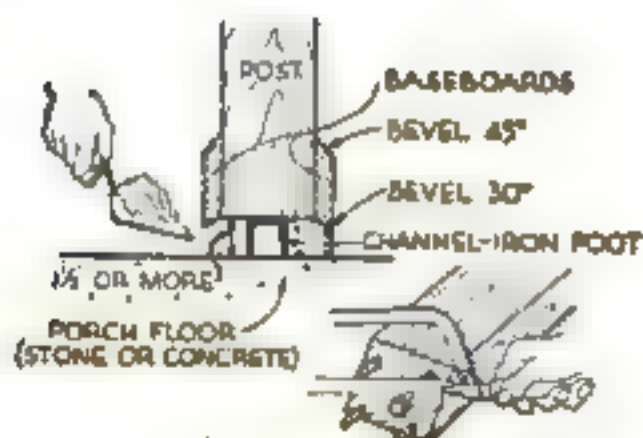
Homemade Baffle Saves Furnace Oil

HEAT often escapes up the chimney of an old round-type boiler or warm-air furnace that has been converted to oil or equipped with a coal stoker. In many cases this can be avoided by installing a baffle 6" to 8" above the combustion chamber. The baffle forces the gases outward to heat the walls.

Construct the baffle of poured fireproof concrete such as can be obtained commercially in a ready-mixed powder. The form is a circle made of sheet metal and divided by another strip. Pour $\frac{1}{2}$ " of the mixture; then set the angles in place and pour the remainder. Let the casting dry for three days before using. Made in two halves, it can be put through the fire door easily. Clamp the pieces together at a slight angle to give the flame a whirling motion.—FRANCIS MARTIN.



Weatherproof Base Under Porch Posts Keeps Wood from Rotting



TROWEL CONCRETE MIX FLUSH WITH BASEBOARDS

CONCRETE bases troweled under posts on a stone or concrete porch will not only be in perfect alignment, but will guard the wood against rain seepage. Bevel both the top and bottom edges of the baseboards as shown, paint them, and nail them in place on the posts, which also should be painted. The top bevel sheds water that drains down the posts, while the bottom bevel keeps wind-driven rain from entering and also gives the concrete bases a bevel that permits drainage of any water entering at the top.

Set the posts on metal feet and wedge them in plumb between the floor and ceiling. Then wet the floor under the posts, pack concrete between and around the feet, and trowel the outside flush with the baseboards.

A concrete mix consisting of 1 part Portland cement, 2 parts fine sand (washed), and 2 parts clean pebbles (up to $\frac{1}{2}$ ") will be found completely satisfactory for the job. Mix the ingredients to a stiff consistency, using only a little water.—J. M.



Plywood PT Boats Are Making History

TINY CRAFT SET RECORDS IN CONSTRUCTION AND PERFORMANCE

TOUGH, hard-hitting little PT boats made of plywood have been making history in all of the Seven Seas throughout their vivid career during World War II. Armed with torpedoes for attack, powered by engines as eager as their officers and men, these PT's have proved their worth time and again, and revealed themselves as indispensable assets to the naval equipment of the United Nations.

Material for decks and cabins on these patrol torpedo boats of the U. S. Navy is

molded plywood, reinforced by suitable internal bracing, and armored with steel plating. The boats are proving themselves daily where light draft, high speed, maneuverability, and stamina are requisites for successful operations.

There is no sacrifice of strength because of the use of plywood as a basic material for these boats. The individual layers of veneer that go to make up the plywood are bonded together under heat and pressure with a synthetic phenol formaldehyde resin

known as Tego, which, under such conditions, becomes an adhesive that makes a joint stronger than the actual wood. Another synthetic resin adhesive, Uformite-CB-551, is used in putting together prefabricated sections of the boats. Uformite has most of the properties of Tego, with the added advantage of being cold-setting. The production of assault boats has been greatly speeded by the use of plywood, since the sections can be premolded and then assembled later on.

Photo by U. S. Plywood Corp.



Molded plywood is used for hulls of Army boats, but only for the deck and cabins of Navy PT boats

An 18-foot molded section of a plywood boat can be easily carried by two men to the assembling plant



1 An early operation in the making of plywood from which PT boats are built is the bonding of the veneer and phenol formaldehyde adhesive under heat and pressure

2 Pulling back the layers shows how this plywood is made up of alternate sheets of veneer and adhesive



2



1



3 A molded plywood section for an assault boat is shown being put in place on the wooden ribs of the craft. These sections are shaped to exact form and size before being brought to the plant for final assembly



3

4 Placing fabricated transverse bulkheads in a molded plywood boat on the Higgins Industries assembly line. The dimensions of the boat can be estimated by comparison with the size of the men, and its light but rugged structure plan is apparent

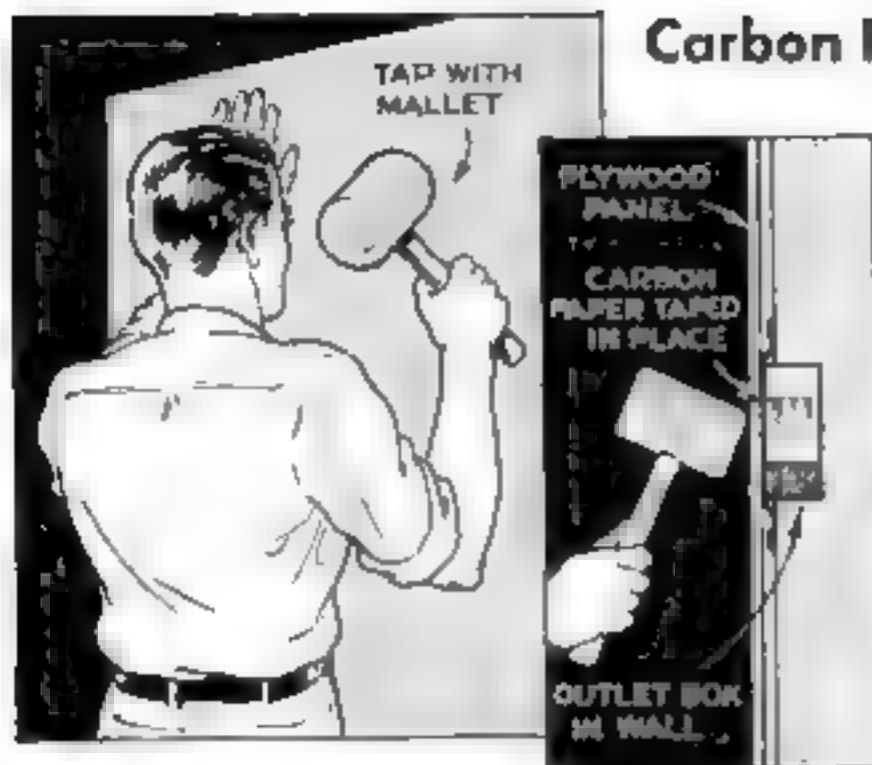
5 Here the gunwales are being glued and nailed into place on an assault boat destined for use by the U. S. Marines. The adhesives used in the manufacture of plywood and its fabrication into boats are made of waterproof synthetic resins and form a joint that is even stronger than the wood itself



4



5



Carbon Paper Is Aid in Cutting Wall Board

WHEN you are ready to cut the wall-board or plywood panels for a new attic room, a closet, or the like that has switch and receptacle boxes already in place on the studs, it's not always easy to locate just where to cut the holes for these outlets. I found in building a darkroom recently that the large number of electrical fittings made this job extra difficult. So I took pieces of carbon paper and taped them, face out, over the receptacle boxes. Then I set the plywood sheet in place and tapped it with a mallet. The outlines of the holes to be cut were then shown clearly on the back of the panel.—LEONARD C. CROWTON.

Metal Stock Is Bent or Tempered with Soldering Transformer

HANDY in working small pieces of metal, a soldering transformer makes a flexible source of heat for bending and tempering operations. A transformer of this type, (see P.S.M., Jan. '44, p. 153) works by bringing a carbon electrode to an intense heat, not by drawing an arc. Clamp the part in a vise, connect the ground clamp to it, and touch the carbon to the place where a bend, say, is to be formed. If the stock is fairly thin, it will soon become red hot and can be readily shaped. Another use is to temper or to draw the temper of hardened steels—a method that's often convenient because a limited area can be



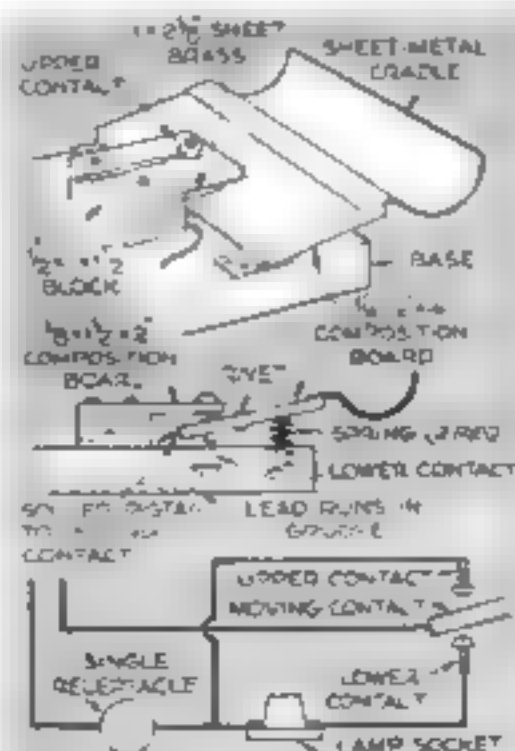
treated. In a pinch, when the right drill isn't at hand, you can even burn holes through sheet metal with a finely pointed carbon electrode as the tool.—H. P. S.

Device Limits Soldering-Iron Heat Between Work Periods

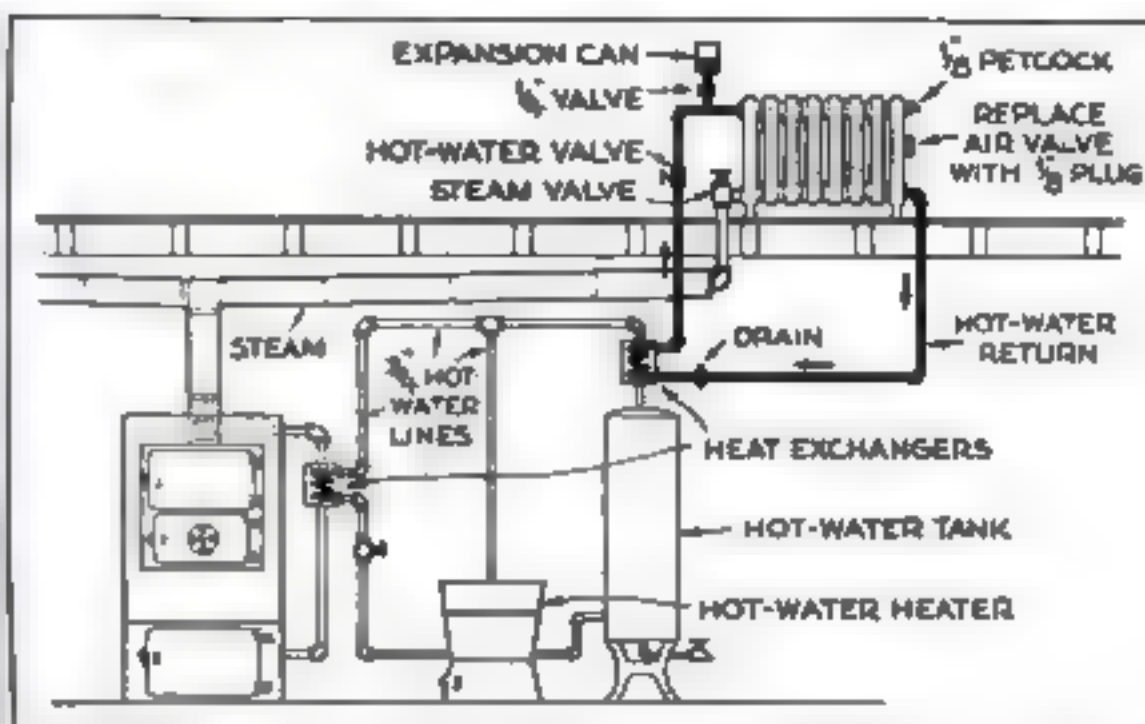
SOLDERING-IRON tips last longer if this device is used to restrict the voltage supplied to the iron except during its actual use. When lifted from its holder, the iron receives the full line voltage; when it is returned to the holder, the voltage is cut down to an amount sufficient to keep it moderately hot. The iron will regain soldering temperatures a few seconds after being picked up.

Mount on a wooden base a lamp socket and a receptacle for the soldering-iron plug. At one end hinge a piece of $\frac{1}{8}$ " hard composition board and fit it with a metal cradle for the iron. Midway on the hinged side

rivet a U-shaped piece of copper or brass and solder a pigtail connection to it. A brass screw set into the base below forms the lower contact, while the upper contact is mounted on a piece of composition board supported on a wood block. Cover the exposed upper nut with sealing wax. Two blind holes bored in the base hold springs that keep the upper contact closed except when the iron is in its cradle. A bulb in the lamp socket serves as resistance; the size will vary between a 15-watt bulb for a small radio iron to a 100-watt lamp for a large one. Determine by experiment the size of bulb needed for your iron.



Auxiliary One-Radiator System Saves Furnace Fuel on Mild Days



ON COOL spring and fall days, when the regular heating system is not in operation, it is nice to be able to heat at least one room. In my home, I connected the kitchen radiator to a heat exchanger let into the delivery pipe from a small coal-fired hot-water heater. On many cool days it has saved me the trouble of firing up the steam furnace by keeping the kitchen quite comfortable.

I used a standard heat exchanger, piping its upper outlet to the top of the radiator. The pipe has a shut-off valve and, farther up, a tee in which is set a $\frac{1}{4}$ " valve connected to an open-top expansion tank. This is a large fruit-juice can. At

The heat exchanger is let into a hot-water line near the tank



the opposite end of the radiator I plugged the air-valve hole, installed a $\frac{1}{8}$ " petcock, and ran a hot-water return pipe from the bottom to the heat exchanger through a tee, in the take-off side of which I screwed a drain cock.

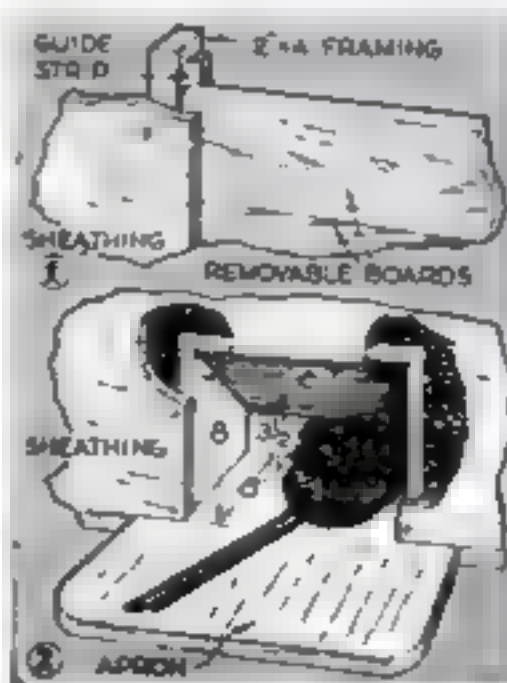
To fill the system, I shut the steam valve, open the $\frac{1}{8}$ " petcock to allow air to escape, and open the expansion-tank valve. I then connect the drain cock of the hot-water tank to the drain cock of the auxiliary system through a hose and fill the radiator until water is visible in the expansion tank, meanwhile remembering to shut off the petcock when water spurts from it. The $\frac{1}{4}$ " valve is left open.—JOHN D. COOK.

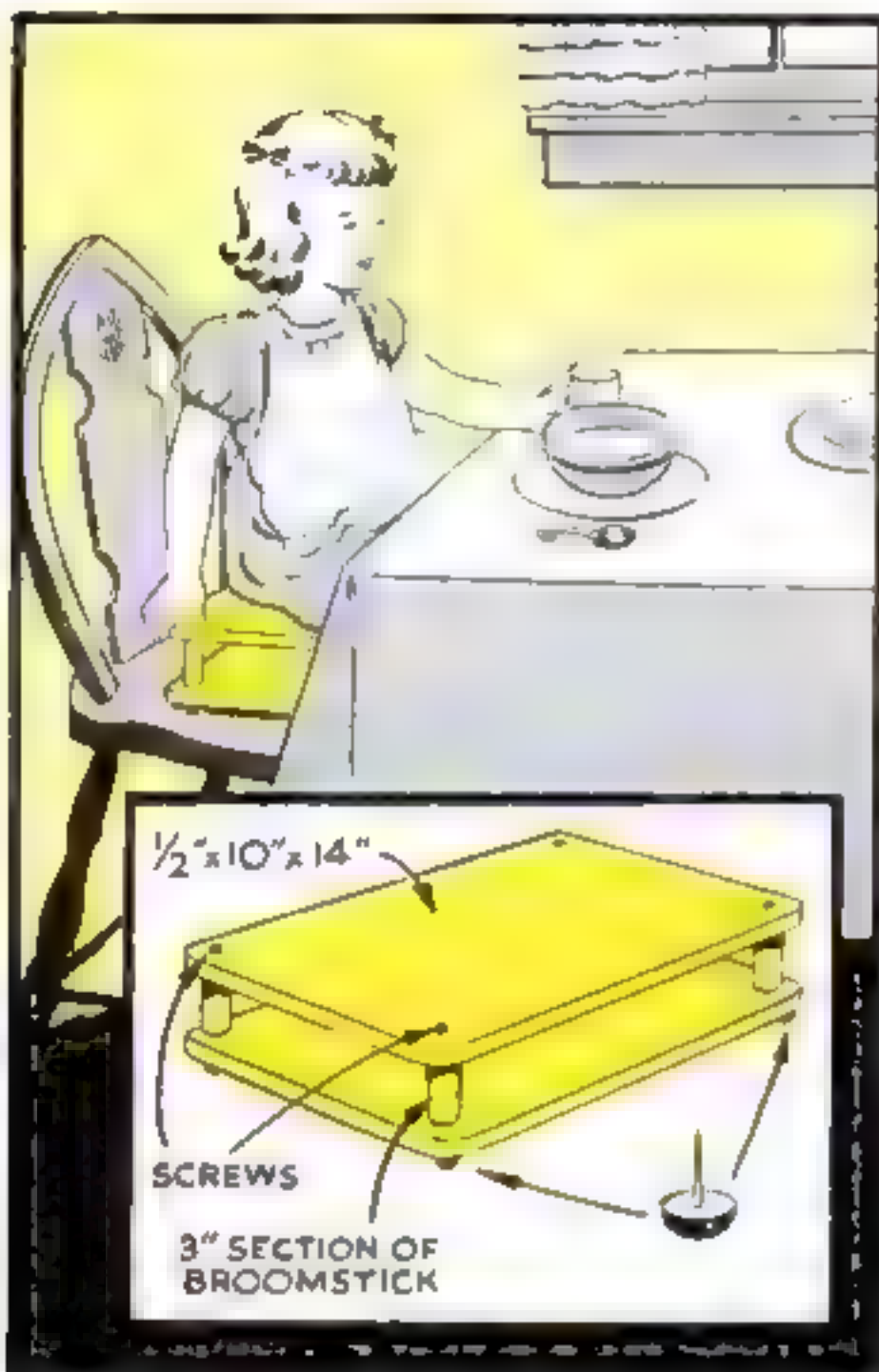
Novel Coalbin Doors Ease Hand Stoking of Furnaces and Stoves

TO FILL a coalbin to capacity, the shovel door should be adjustable as to height. The door shown in the photograph at the right can be constructed when the bin itself is being built. Extend the sheathing about $\frac{1}{2}$ " past the two studs framing the doorway (Fig. 1). A $\frac{1}{4}$ " by 1" strip nailed to each stud as shown in the drawing forms a channel into which loose boards are slid. As the coal is consumed, you can lower the height of the door accordingly by removing one board after another.

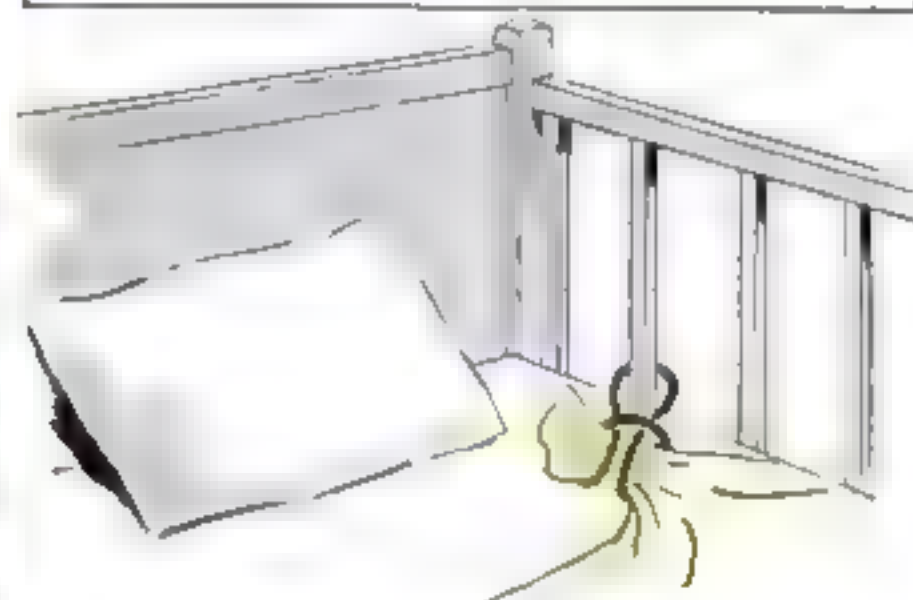
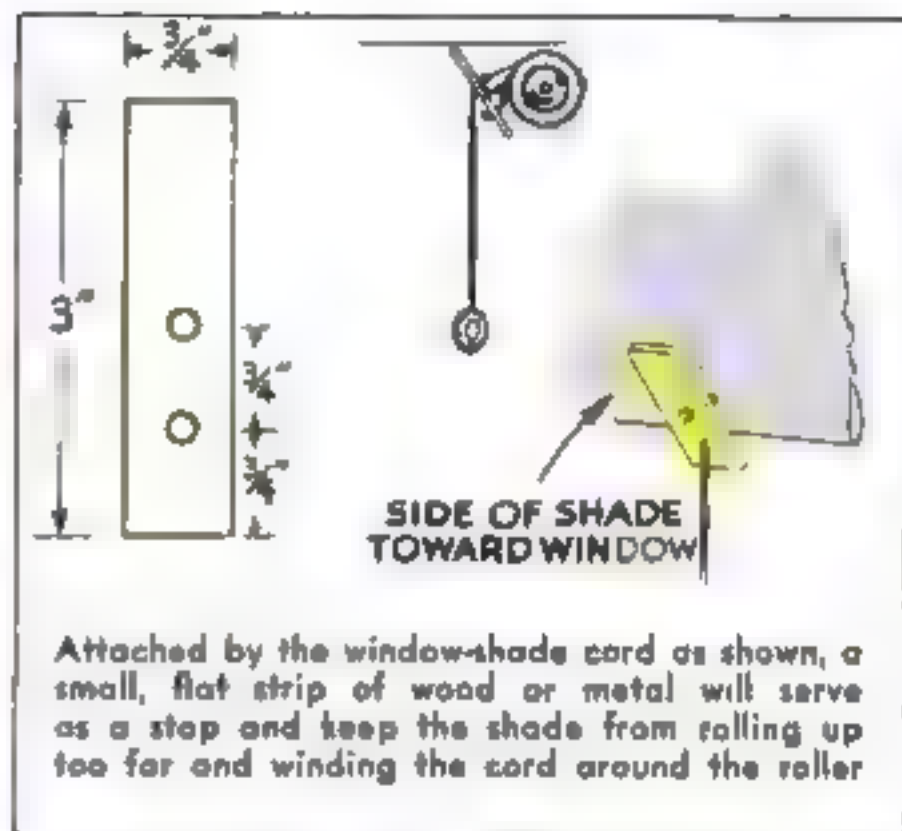
Small bins located near room heaters can be kept from becoming a dust nuisance in the home by fitting them with hoppers like that shown in Fig. 2. With such a door, a bin can have a dust-tight lid. An apron fitted as

shown makes it easy to sweep back any coal dropped from the shovel. The $8\frac{1}{2}$ " throat is right for pea coal. Make it larger for other sizes.—J. MODROCH.





A child too small to use an ordinary chair will be more comfortable on this seat than on the usual stack of books or pillows. Rubber-headed tacks prevent slipping and damage to the finish.

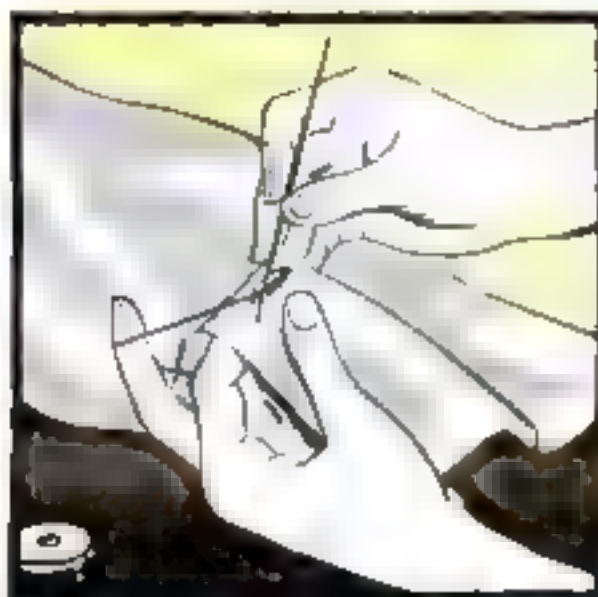


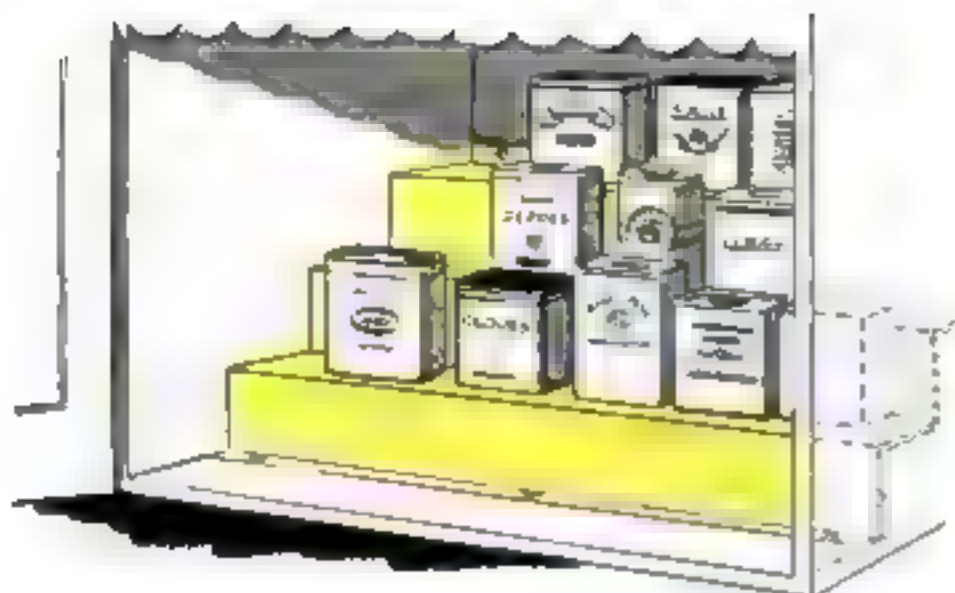
Ties made by knotting cord loosely around posts near the head of a crib will secure a blanket on a baby. The cord is drawn tight after a corner of the blanket has been pulled through its loop.

Use of a crochet hook will be found a convenience for making buttonholes in heavy materials. A hook is ideal for working the loops in the buttonhole stitch.

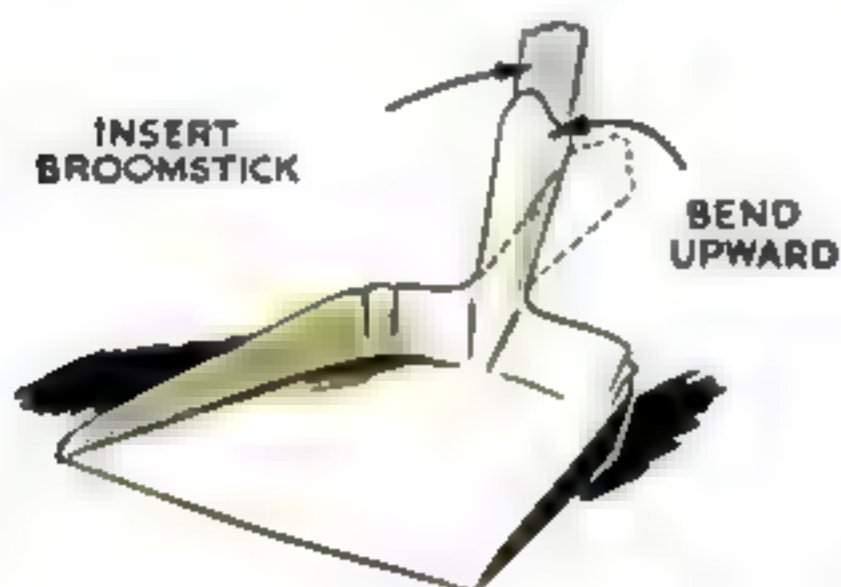
One way to tighten a clothesline quickly is to wind the slack on a device cut out like the one shown below. Twist the line on legs on the side opposite to the hump.

When rust spots begin to form on the frame of a typewriter, they can be removed with an ordinary eraser. A coating of clear nail polish then rustproofs the spots.



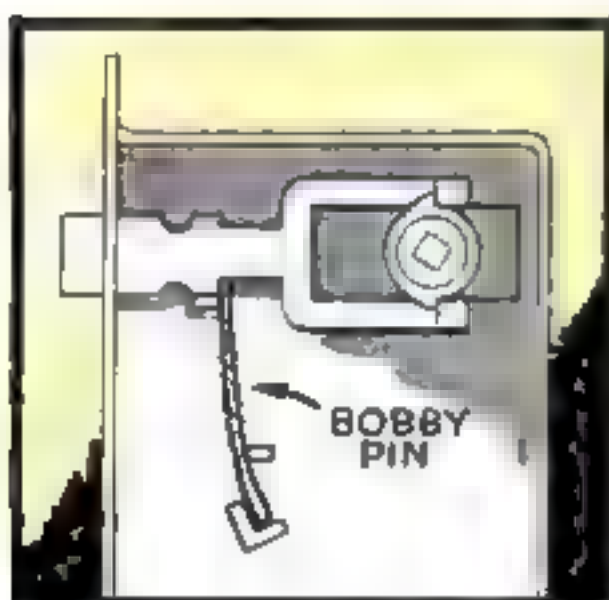


Stepped shelves inside a cupboard will convert it into a spice cabinet in which all containers will be visible. The steps may be bent out of sheet metal and screwed fast or built from light wood

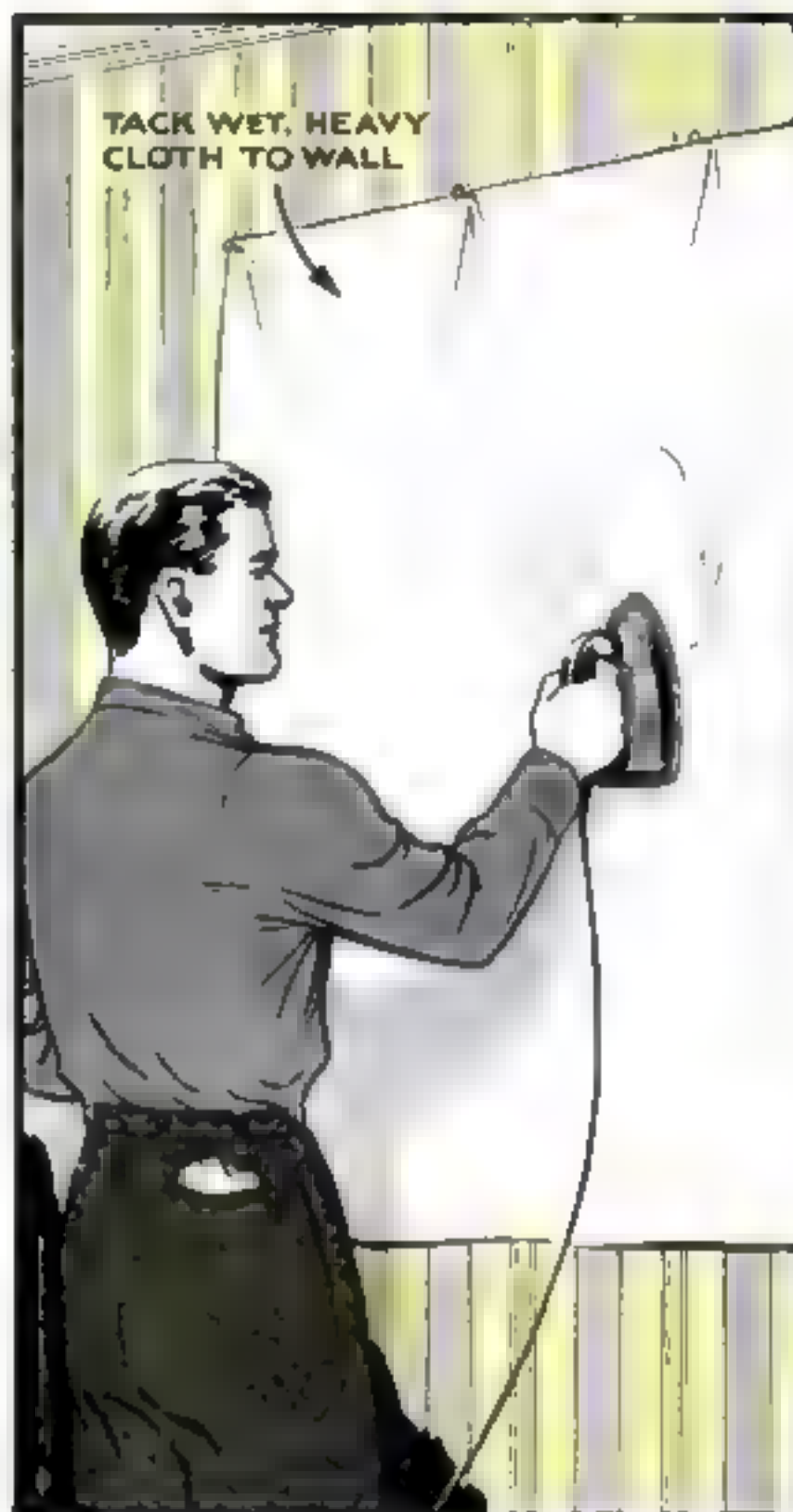
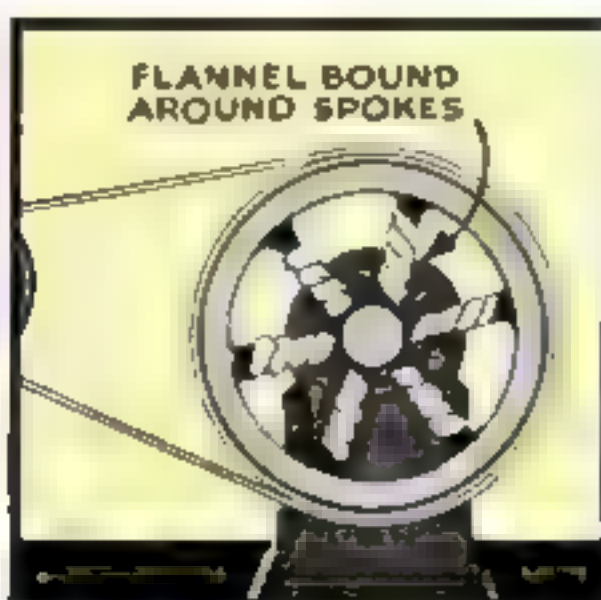


Steeping to pick up sweepings in a dustpan can be avoided by equipping an ordinary dustpan with a handle cut from an old broom. Taper the handle to fit, if necessary, and bend the metal upward

If it is difficult to obtain a new flat spring for a mortise door lock, a bobby pin inserted for the broken piece will be a good temporary replacement

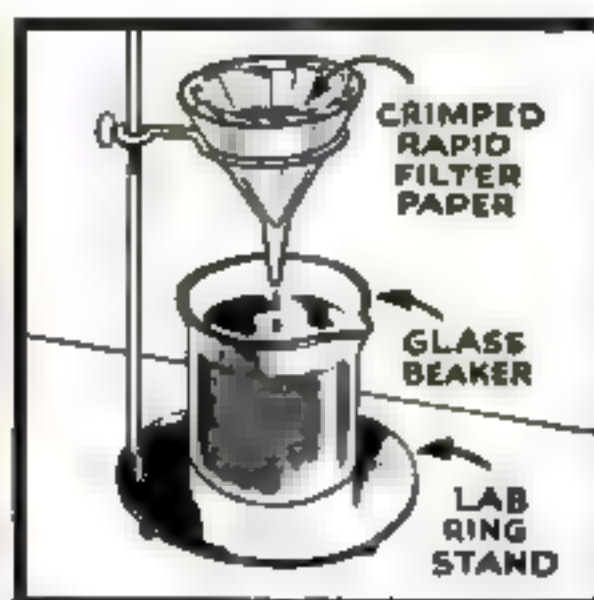


Oil seeping from water-pump bearings can be kept off the belt by wrapping strips of flannel about the pulley spokes. This prevents belt slippage and loss of power



Old wallpaper can be steamed loose in preparation for new papering by tacking over it a wet sheet or a wet, heavy cloth and pressing with a hot iron. Scraping with the putty knife will then be easy

Those having laboratory equipment can use a funnel, a filter paper, and a beaker for a coffee maker in an emergency and brew excellent coffee by pouring on boiling water



DISAPPOINTED IN YOUR RECENT HOME FILMS?

TUNING UP YOUR

By WALTER E. BURTON

IN THE showcase was a 16-mm. Filmo with few signs of wear, and even at war prices, it was reasonable. True, it had no lens, but at home there was a 1" Velostigmat F/3.5 that would do nicely.

Any used camera may be looked upon with suspicion in spite of appearance, and this Filmo, on reaching home, got a tune-up that ended with the fitting and focusing of the lens. An overhaul is a good tonic for any movie camera more than two years old.

Go over the outside with a damp cloth; then open the camera and, with a cloth and artist's brush, remove all the lint and dirt you can spot. Take extra pains to brush grit from the film-guide shoes, film gate, and wherever the film touches. A small syringe will also help.

If the camera construction permits and you feel skillful enough to get all the parts back in the right place, you can take out a few bolts and gain access to the shutter mechanism and motor. In the camera shown, removal of four bolts in the turret-like front permitted the shutter assembly to be lifted out bodily. (When this was done, the shutter button had to be held to keep it and its spring from flying out.)

After cleaning, apply oil. An instruction book will tell you where, but you can rely on your judgment. The spring-motor bearings or gears, gear teeth, shutter cam, claw crank, and the like work smoother when lightly oiled. But be careful, for improperly applied oil may freeze in extremely cold weather. Use a good grade of watch oil or its equivalent, and don't apply it where it may spread onto the film. Mechanisms gummed by oil may be cleaned with any good dry-cleaning fluid.

Cleaning an open-type view finder is simple. Lens mounts of the telescope variety must be pried out or unscrewed to expose all lens surfaces. Clean the glass with cotton or cloth swabs moistened with lens-cleaning fluid. You can use soap and water, but



When a home-movie camera is cleaned, go over the outside first with a damp cloth; then open the camera and remove all the lint and dirt you can find with a cloth and an artist's brush. Here a brush is used to remove grit from one of the film-guide shoes.

rinse off the soap completely and don't let water seep around the edges of the lenses.

Reassemble the view finder and check its alignment by clamping the camera on a tripod and running a short strip of film through to photograph a definite area. Develop the strip, compare it with the finder-lens image, and adjust the finder if the images don't match. In rare cases the camera lens may fit poorly or be misaligned. If the finder field slopes when the camera is level, rotate the front lens and its frame or mask until the field is level.

The camera may be lost or smashed if the carrying handle or strap falls, so test all fastenings. A few drops of shellac, paint, or quick-drying cement help tighten loose screws, or the holes may be tapped for larger screws. One or two applications of a good shoe dressing, polished until no wax remains to rub off, aid in preserving a leather handle, strap, or covering. Glue down taggles and raised places on a leather covering with quick-drying cement.

Crackled or wrinkled enamel is not easy to touch up where bare metal shows through, but a dull or spotty finish may be cleaned with a cloth moistened with dry-cleaning fluid, waxless paint remover, or

MAYBE IT'S THE FAULT OF THE EQUIPMENT

MOVIE CAMERA

lacquer thinner, and the luster may then be restored with clear brushing or linoleum lacquer applied thinly with a cloth and rubbed well. Orange or white shellac to which a little linseed oil has been added may also be rubbed on until a polish results. Or you may rub on a good varnish or even automobile, floor, or shoe wax.

The camera shown had a lens hole about 1" in diameter and the Velostigmat lens used had a threaded base about $\frac{3}{8}$ " in diameter, so an adapter was needed. A brass ring was turned in a lathe and threaded to match the lens and camera threads. The distance between the front of the adapter ring and the film will depend on whether the lens is in a focusing mount or is to be used at a fixed focus. If it is a focusing type, set the scale at infinity and focus on an object 100' or more away on white cardboard or ground glass. Measure

the distance from the card or glass to the shoulder of the lens mount. This determines the length of the adapter ring required to place the shoulder the same distance from the camera film. For a fixed-focus lens, focus in the same way on an object at the hyperfocal distance for the largest aperture.

Thin washers may be needed between the lens and adapter ring or between the ring and camera to get the adapter at precisely the right position. They may be cut from thin metal such as .005" sheet brass.

To focus a movie-camera lens critically, magnify the image with a compound microscope, a magnifying glass of about 10X power, or critical-focusing attachments available for some cameras. If the camera can be taken down and the film-aperture plate exposed, the magnifier can be focused over the entire image area. The image may be



Removal of four bolts in the turretlike front of the camera shown above permits the shutter mechanism to be taken out bodily for cleaning with bits of cloth. A syringe is often convenient for blowing out dust.

After a crackled-enamel finish on a camera has been cleaned with dry-cleaning fluid, the luster can be restored with clear lacquer, shellac and linseed oil, or a good polishing wax rubbed on thinly with a cloth.



Cotton swabs moistened with lens-cleaning fluid are used to clean the view finder. Lens mounts of the telescope type must be unscrewed or pried out in order to expose all surfaces of the lens.

One or two applications of shoe or other leather dressing not only improve the appearance of a leather carrying handle, but also help preserve it. Polish until no wax remains to be rubbed off.



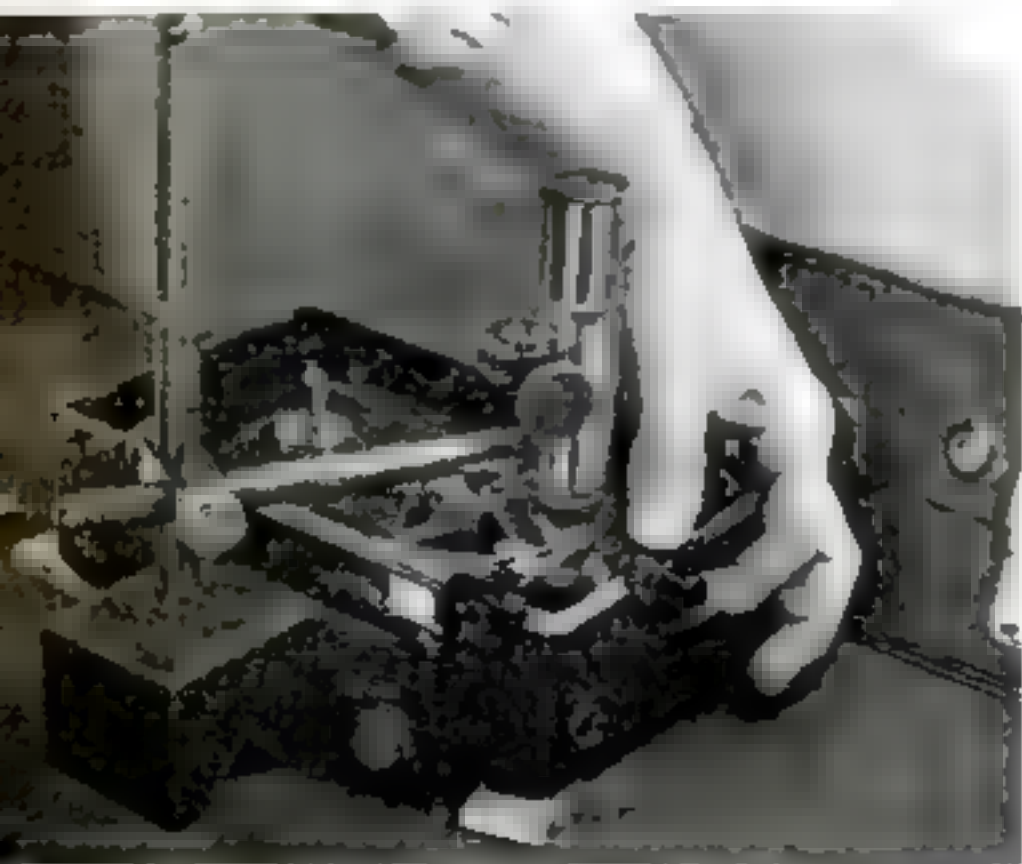
formed on fine ground glass mounted over the film aperture if a magnifying glass is used. But since ground glass under a microscope at, say, 30 or 40 diameters looks like cobblestones, use in this case plain glass having a few lines scored with a glass cutter or abrasive paper on the surface next to the aperture. Focus the microscope sharply on one or more of the scored lines. Then, when the image is in proper focus, it will be clear, sharp, and superimposed on the lines. If the image is indistinct and the lines sharp, the lens is out of focus.

Cameras like the Cine Kodak Model B shown in one of the photos are focused without removing anything except the cover. Behind the film aperture there is a small hole through which a portion of the image can be seen. Place a small mirror behind this hole at an angle of 45 deg. with the camera-lens axis. Using a magnification of 30 diameters or so, focus the microscope to magnify the reflected image of the hole.



When the lens at right was fitted to the camera, a brass adapter ring had to be turned and threaded. The ring is shown here with washers needed with it.

Below, in focusing a newly mounted lens, a mirror is placed at a 45-deg. angle so the microscope can be focused on the small opening behind the film.



Place in the gate a piece of undeveloped film or a strip of mat celluloid with the mat or ground surface toward the film aperture.

In focusing with a magnifying glass or microscope, a bright image is required. A 60-watt lamp enclosed in a protective guard like those used with garage extension cords is excellent; the bars of the guard are sharply silhouetted against the bulb.

Fixed-focus lenses are adjusted so the region of reasonably sharp focus extends from infinity to within a few feet of the camera. It is a property of lenses that, for a given aperture and focal length, there is one focal distance at which an object anywhere between infinity and a point halfway between the focal distance and the camera will be in focus. This is the hyperfocal distance. Thus, for a 1" F/3.5 lens, the hyperfocal distance at maximum aperture is 24', and objects from 12' to infinity are sharply focused. So, in mounting a fixed-focus lens, set it for the hyperfocal distance at maximum aperture. As you stop down, the near boundary of sharp focus moves closer in and the far boundary still extends to infinity. The following tables will help you determine the proper setting.

For a lens of 1" focal length:

Aperture	Hyperfocal distance	Nearest point of sharp focus
F/2	41 1/4'	21'
F/2.5	33'	16 1/4'
F/3.5	24'	12'
F/4	21'	10 1/2'
F/4.5	18 1/4'	9 1/4'
F/5.6	15'	7 1/2'
F/8	11'	5 1/4'
F/11	7 1/4'	4'
F/16	5 1/4'	2 3/4'

Now suppose you have a 1" F/3.5 lens set at the hyperfocal distance of 24' and you stop the lens down to different apertures. Here is what happens:

Aperture	Nearest point of sharp focus
F/3.5	12'
F/4	11 1/4'
F/4.5	10 1/4'
F/5.6	9 1/4'
F/8	7 1/2'
F/11	6'
F/16	5'

If you want to figure out hyperfocal information yourself, here is how: To find hyperfocal distance in inches, multiply the focal length of the lens by 1,000 and divide the product by the aperture (F-number). Divide again by 12 to get feet.

For the closest point of sharp focus at a given aperture: (a) multiply hyperfocal distance for that aperture by the distance for which the lens is focused; (b) add hyperfocal distance to the distance for which the lens is focused; (c) divide (a) by (b).

LAMP STAND AND DIFFUSER FOR INDOOR PHOTOGRAPHY

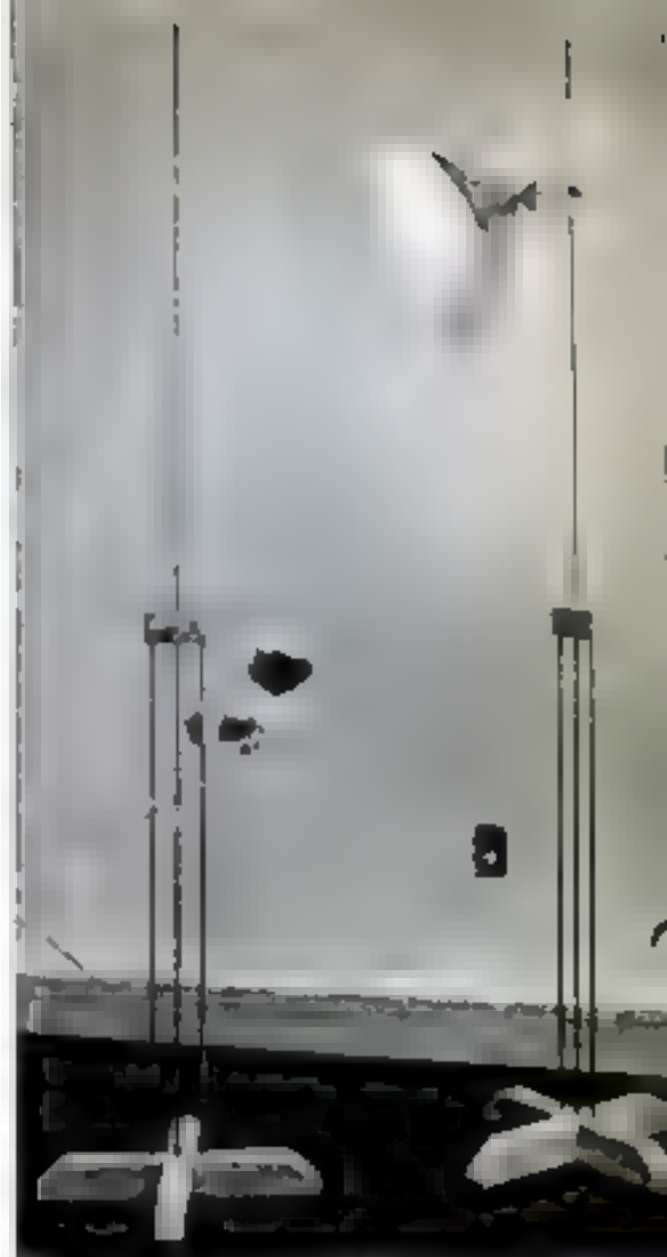
WITH few tools, at no great cost, and from easily obtainable materials, you can make your own photo-flood equipment, providing yourself with a set of lamp stands, reflectors, and diffusers that a professional photographer would be glad to own. The stands shown here are adjustable to a height of approximately 9', yet they are light enough in weight to be moved about readily. They permit the clamping on of one or more lamps at any point from a few inches above the floor to the extended tip.

Each stand is made of two 6' pieces of 5/16" cold-rolled steel rod or similar lengths of 1/2" pipe, solid curtain rods, or "Bessemer rod." Cut one length in half to form the legs, and use the other in one piece as the sliding upright. The crossed feet and the brace at the top of the legs are shaped from hardwood. Bore the holes for the legs for a tight fit, but those for the sliding rod should be reamed slightly larger than the diameter of the rod.

Clamps for the lamps are sawed from hardwood blocks bored as shown. Those holes in which the rods are inserted should be an easy sliding fit. To hold the diffuser arm tight, the clamp for this piece is given spring with a saw cut as shown in the drawing. Winged setscrews can be formed by

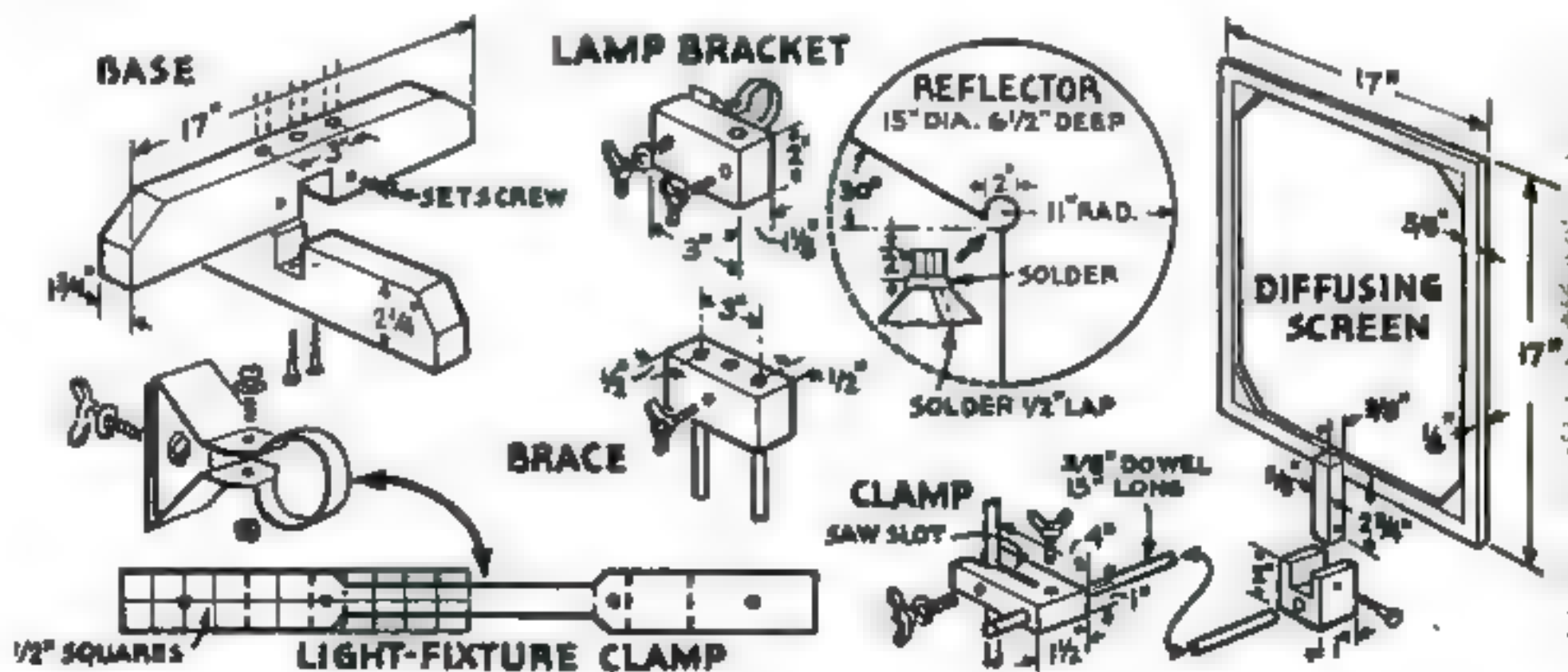


Photo lamps may be clamped on either the upper or lower members of these stands in order to light up the subject properly. The diffuser shown at left is tracing cloth stretched over a frame

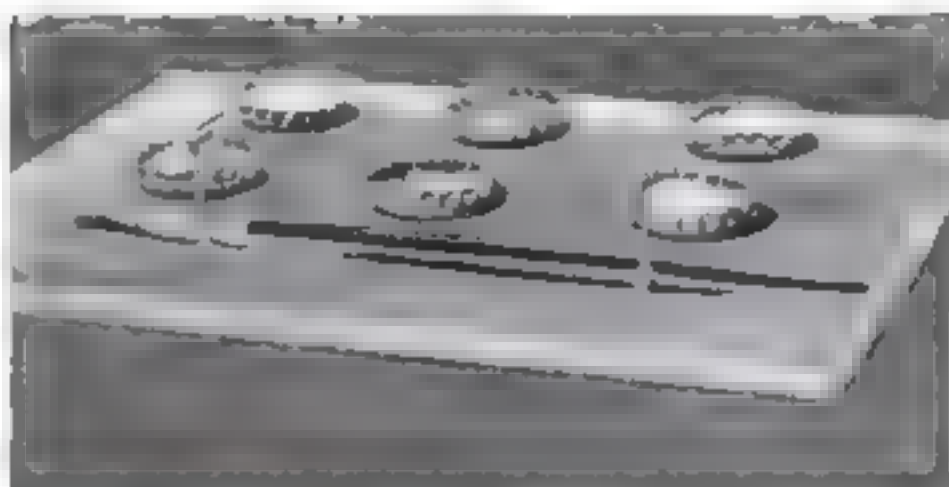


slotting the heads of 1/4" bolts and soldering in halves of common washers. Bore undersize holes for the setscrews and tap them with the setscrews themselves.

Sheet metal is best for the reflectors, but white cardboard will do if it does not touch the bulb. Finish the inside of metal reflectors with aluminum paint. Clamps for the light receptacle are made from tin-can material cut as shown and soldered. An efficient diffuser consists of a wooden frame with tracing cloth or paper stretched over it and tacked.—C. W. B.



TINT CUPS that will be a convenient accessory in coloring photographs can be made from ordinary bottle caps. Fasten the bottle caps to a board with glue or with small nails set close outside the edges, using six or more caps, as desired, and being sure to allow one extra for clean water in which to rinse the brush. Two nails or screw hooks driven into the board as shown will hold the brushes or retouching pencils that are not in use.—HERMAN KLEIN.



NUMBERING CUT FILM will be done automatically by small notches cut in the margins of individual cut-film holders. Make the shallow notches in each holder with a chisel, as indicated in the drawing. Each notch can represent the numeral "one" or, if preferred, notches near one side may represent "fives" and notches at the center may stand for "ones." Light through them will be reproduced as black marks on the edges of the negatives. Numbered in this way, negatives can easily be identified for notes on exposure or the like.



SHARP ENLARGEMENTS are the result if you use a focusing strip, but the extra steps involved are often tedious. I mounted my focusing strip between two sheets of glass and two pieces of composition board to make a holder of the same size as the regular negative carrier. This permits me to focus accurately with the strip and then to replace it with the negative carrier, and makes it unnecessary to put the strip in the carrier, focus, and then put the negative back in the carrier.—F. BRAUCKMANN.



CALIBRATION of magnification factors at various distances for as many as four enlarger lenses can be marked on a square strip of wood set on a base. Place a transparent ruler in the negative holder and measure the projected image for calibrating. Affix a pointer or put a reference mark on the enlarger head to align with the numbers when marking them and whenever setting the head thereafter.—C. Y.

HALF THE CIRCUMFERENCE OF LENS MOUNT



PATTERN OF ADAPTER



LOW-COST FILTERS may be utilized on your movie or still camera with the adapter shown above, which permits the use of inexpensive, unmounted filter disks. Cut a piece of paper to the pattern shown at left above, scaled to fit your lens barrel, and lay out the pattern on tin-can stock. Thin spring brass of the type used for some weatherstripping will serve better if obtainable. Turn under the ends of the main section and curve it to fit about three quarters of the way around the lens barrel. The three arms are bent at right angles to the main section, with their ends turned back to hold the filter. Smooth the adapter with a fine file and emery cloth, and cover it with photo tape, to avoid scratching or otherwise marring the filter or lens mount.—ROBERT SCOTT.

FILM VIEWER GIVES MAGNIFIED IMAGE

By ERWIN WALTERS

MINIATURE-CAMERA negatives and movie film can be examined for flaws and judged for sharpness and printing quality with a magnifier like that shown at the right. The one illustrated was made from scraps of brass, but any non-corroding metal or even plastic or cardboard could be used.

Essential parts are the tube holding the lens at one end, and a plate soldered to it at the other. This has strips at top and bottom that are slotted to serve as film tracks. The drawing gives dimensions for a viewer used with a 24-mm. lens having a 76-mm. focal length. Such a lens gives a magnification of about four diameters and will just cover the full width of a 1" miniature negative. For a lens of different diameter and focal length, the dimensions should, of course, be changed.

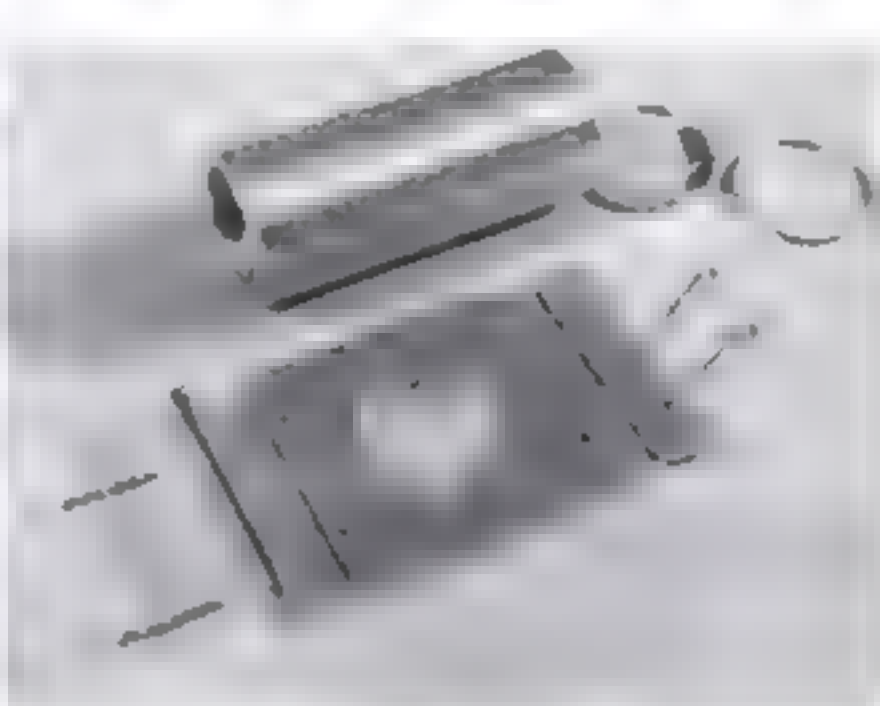
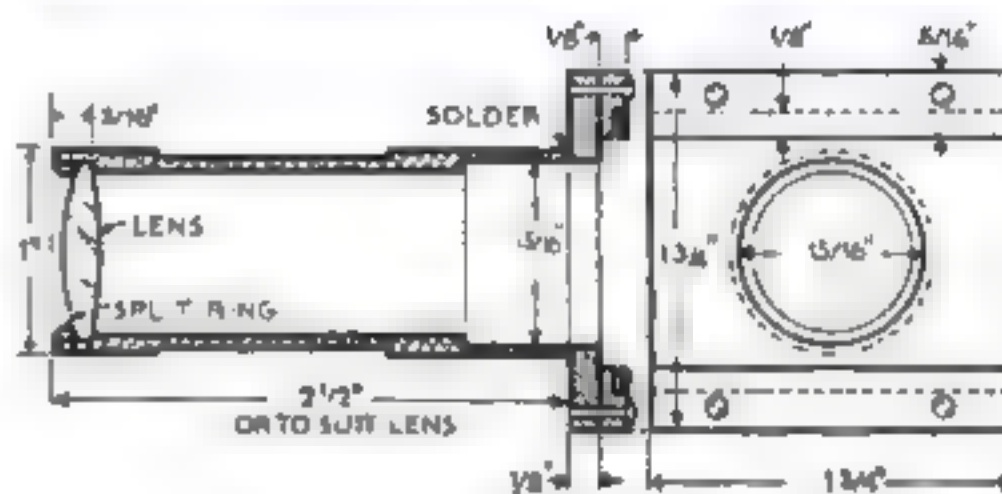
The dimensions of the plate carrier shown are for the accommodation of 35-mm. miniature-camera film. If 8-mm. or 16-mm. movie film is to be inspected, the dimensions of the plate may be scaled down or, better still, separate adapter plates may be made to slip into the grooves of the

Rivet each guide strip to the plate with two brass escutcheon pins. Countersink the holes slightly, cut the pins off almost flush, and hammer the ends

35-mm. plate. The adapter plate would be similar to the 35-mm. plate, but it would be only 1 1/4" wide and would have lugs to slide in the grooved strips of the other. It would be equipped with strips slotted to take the edges of the film to be viewed.

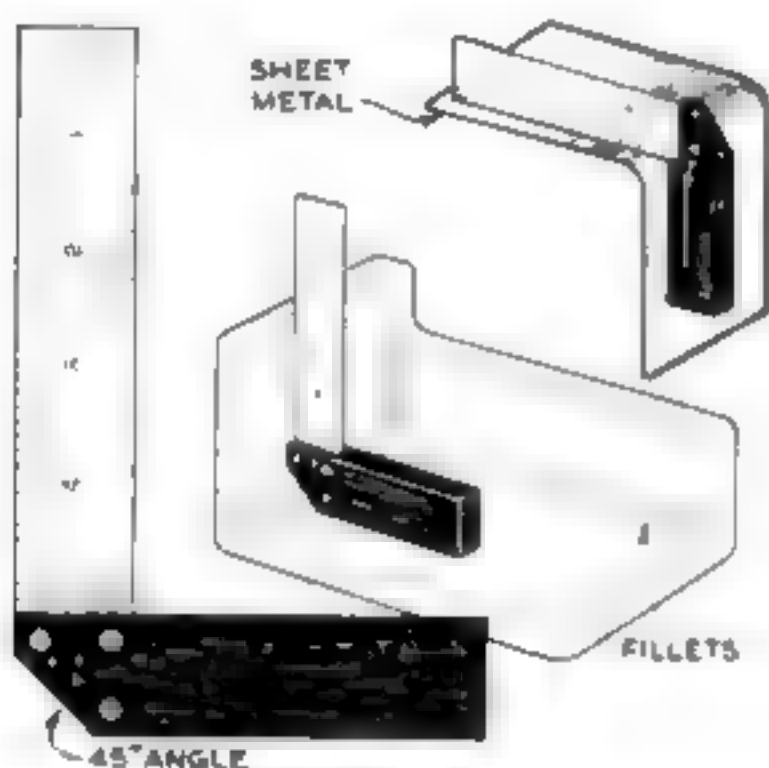
Put a coat of nonreflecting black paint on the inside of the tube and the outer surface of the split ring holding the lens.

Here are all parts of the viewer before assembly. The tube is shaped inside and out as shown above. Knurled edges simply give the plate a fine finish



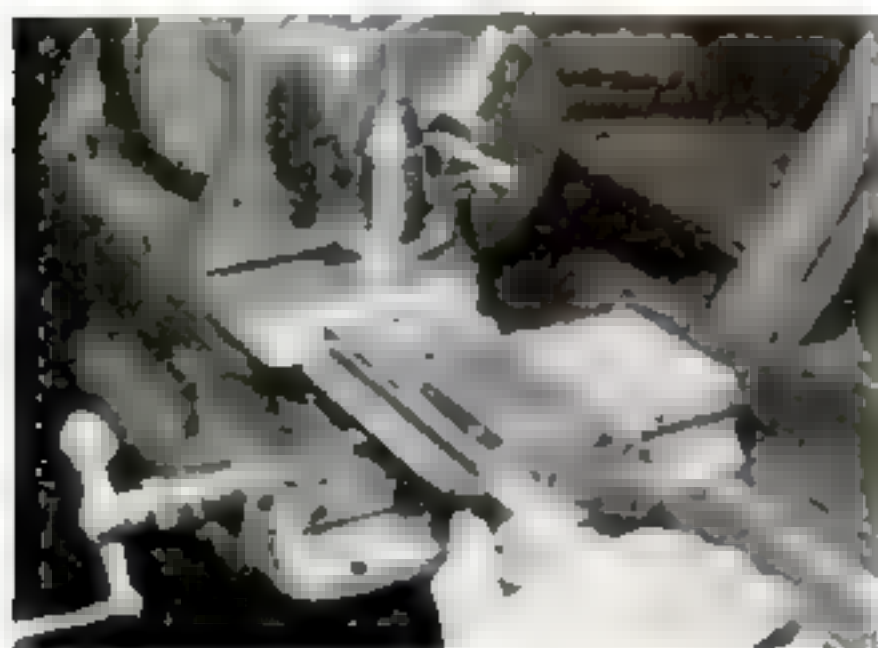
BY SAWING A 45-DEG. BEVEL at the 90-deg. corner of an ordinary try square having a metal, wooden, or composition handle, you can make a "fillet square" that will be useful in welding, sheet-metal work, pattern making, and many other jobs. For welding, where the square may be near intense heat, use a heat-resistant handle that will not be damaged.

If preferred, you can make your own "fillet square," slotting and sawing the handle to shape, and riveting it to a steel rule. Have the zero mark at the far end of the blade and align the inside of the handle with an inch mark.—ALBERT H. DOERR.



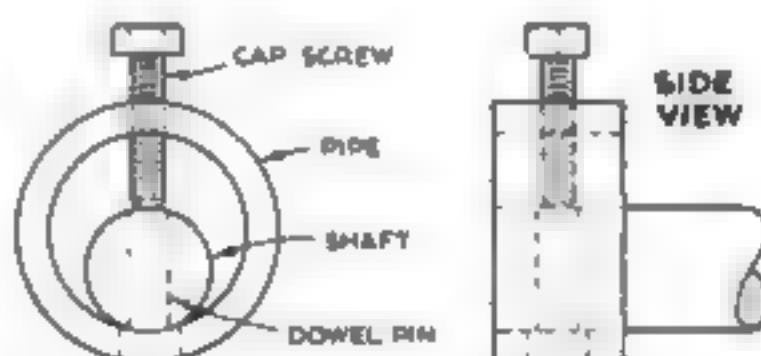
WITH A 4" STEEL RULE bolted to the stationary part of the compound rest with two 2-56 flathead machine screws, and an adjustable pointer on the sliding member, work spoilage will be decreased and practically all boring and turning operations will be facilitated. Drill a 7/32" hole in the slide rest for a 3/16" diameter steel pointer, and drill and tap a hole for a knurled setscrew.

To use the scale, face off the workpiece and set the pointer at 0" so it will show the position of the tool in respect to the end of the workpiece during turning. You can see this at a glance without counting turns of the feed screw, as one must to gauge tool travel by collar markings.—J. C. MAGEE.



WOODEN DARNING EGGS, available at the sewing-goods counter of department and 10-cent stores, or perhaps in the family sewing basket, make excellent handles for carving chisels and similar hand tools. Since they are short and relatively wide and have well-rounded ends, they provide a good surface on which to hammer with the heel of the hand when forcing a cutting tool deep into wood. The shape also permits a comfortable grip for merely grasping and pushing.

If the darning egg is equipped with a handle, it probably will be necessary only to remove this handle to expose a hole that will receive the shank of the tool. An egg that has no handle must be bored at the small end to take the shank. A ferrule cut from tubing may be added to prevent splitting. The original wax finish should be sufficient.—W. E. B.



METAL DOWEL PINS that, because of corrosion in use, have become stuck fast in washing-machine spindles and other shafts sometimes cannot be removed with a hammer and punch without danger of bending the shaft. In such a case, a jig made up of a short piece of pipe and a cap screw, as shown in the drawings above, will prove an invaluable aid.

The pipe is, of course, larger in diameter than the shaft, and the cap screw and its tapped hole in the pipe are smaller than the dowel pin. A hole larger than the pin diameter is drilled opposite the small hole to provide an opening through which the cap screw can force the pin.—R. E.

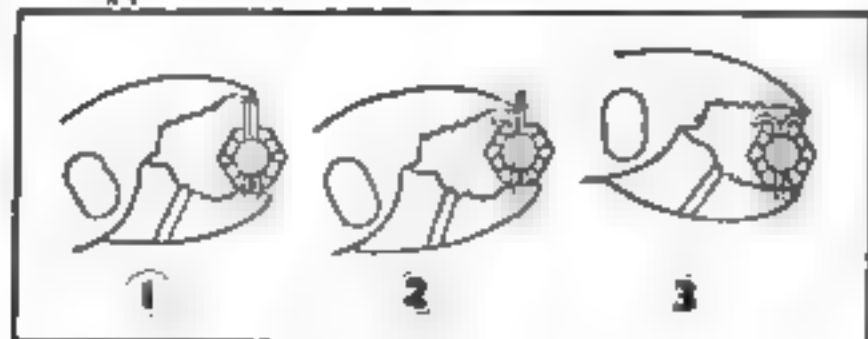


Simple pinch pins secure bit holders in the fly cutter, the shank of which is easily chucked

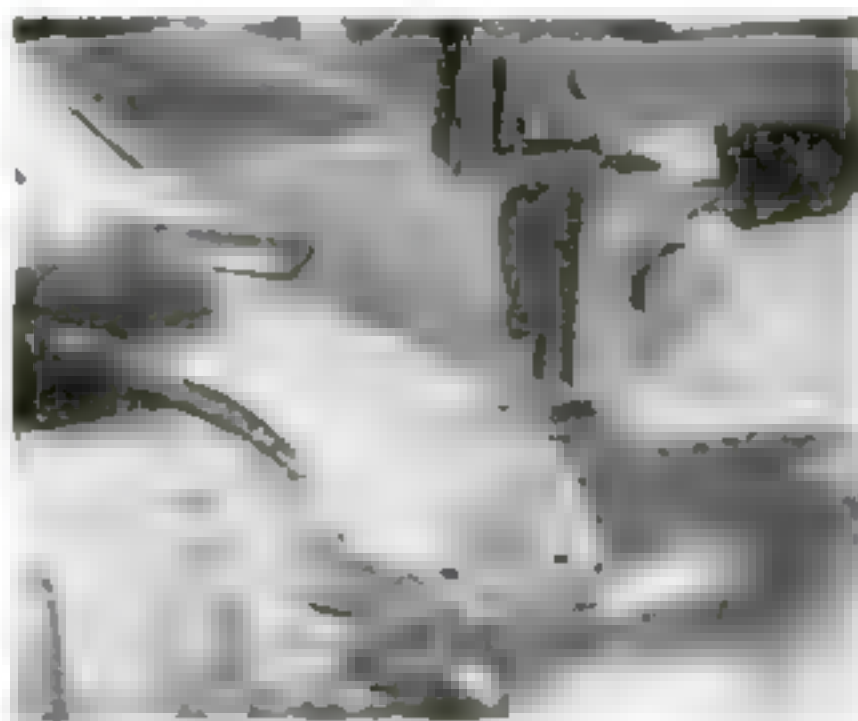


THREE CUTS AT A TIME are taken by a triple fly cutter developed by the Fairchild Camera and Instrument Corp., of New York, for machining dural, aluminum, and magnesium-alloy castings destined for aerial cameras. Some of these have walls so thin they would be damaged by machining with regular milling cutters. With the new method, one bit set slightly above the others takes the roughing cut, one or more others take intermediate cuts, and the last follows through with the finishing cut. As much as $\frac{3}{8}$ " can be removed without warping the metal. End mills may also be inserted for finishing sides and corners.

COTTER PINS are handled quickly with ordinary pliers modified, as shown in the drawings, by Erich Langnickel, of the Flour City Ornamental Iron Co., Minneapolis. One jaw is recessed to take the head and the other ground concave to bend the legs.



WELDED RETURN BENDS for fittings on Liberty ships and tankers are made by the Weber Showcase & Fixture Co., of Los Angeles, by blanking and forming $\frac{1}{4}$ " plate cold in four operations. The bends are formed in halves which, after machining, are welded in rotating jigs by a stationary welding rod. Steps are shown above in a photo from the Hobart Arc Welding News.



BLAZING SAWS, purposely dulled to create maximum friction, now burn and melt their way through heavy armor plate, thick glass, and other extremely hard materials, thanks to Art Schwartz, chief engineer of tool research at the Elmwood Plant of the Bell Aircraft Corp., of Buffalo, N. Y. Ordinary soft-tempered carbon-steel blades are used at high speed in the "flaming-saw" cutting method developed at Bell's for cutting boiler plate and adopted since by many other war manufacturers.

For best results, the saw teeth are worn down to aligned flats, each of which produces great heat from friction as it strikes the material being cut. As proper cutting pressure and temperature are reached, a blue-white flame shoots out from the blade fed by oxygen carried between the teeth, and this burns its way through the plate. The method is satisfactory only with hard materials; in fact, the harder the material and the more resistance or friction it offers, the better the results.

MINIATURE PUNCH PRESS DOES DIFFICULT JOBS

By W. A. CONWAY and WALTER E. BURTON

SMALL though it is, this device will do easily a number of jobs that are difficult with ordinary tools. Some of these are punching holes in clock springs, sheet metal, fiber, and other materials; crimping metal around a hole to hold an insert; heading rivets or forming wire into small rivets; stamping figures or monograms on jewelry, small machine parts, and the like; driving light wheels and gears on or off shafts; and forming special parts such as grommets for miniature sailboats. Many more uses for it will be found in craftwork, modelmaking, instrument building, and similar delicate work.

Most of the press can be made up of scrap steel. Chuck the piece for the base, drill the $\frac{1}{8}$ " hole along the axis, counterbore $\frac{1}{8}$ ",

and enlarge with a boring bar, as shown, squaring up the end of the $\frac{1}{8}$ " hole. Face off the exposed end, reverse the piece, chucking it with the jaws inside the bore, and turn the outside. Face this end and turn out a $\frac{1}{8}$ " diameter recess $\frac{1}{32}$ " deep. To knurl, grasp the piece near the bottom with the chuck jaws and run the tailstock center into the $\frac{1}{8}$ " hole, as in Fig. 1, for added rigidity. Clamp the piece and run a $\frac{1}{8}$ " drill through a diameter. Open out to $\frac{1}{4}$ " in one wall, and counterbore. These holes receive the eccentric spindle.

Bend the guide arm from bar stock and drill as specified. The flat area at the bottom is drilled part way through for two cap screws, clamped to a matching milled or filed flat on the base (Fig. 2), and aligned



carefully. One hole is then drilled through with a tap-size drill (No. 26 for a $3/16$ "-24 thread). Unclamp, tap the hole in the base, enlarge that in the arm to permit the bolt to pass, remount the arm, using one screw to hold it, and drill and tap the second hole. Now hold the arm with the two cap screws, adjust it carefully on the base, and drill the three holes for locating pins, as shown in Fig. 3. Drive these in and dress down the outer ends. They will locate the arm accurately; bolts alone would permit some play.

Make the punch bushing of drill rod, harden it, and drive it into the upper hole in the arm (Fig. 4). Lap the $3/16$ " hole for $3/16$ " drill rod so that the latter slides snugly in it.

The table shown with the other parts in Fig. 5 is machined from tool steel or from steel suitable for pack-hardening. Machine one flat surface smooth, knurl, and separate the disk from the stock. Drill and tap the center hole shown in Fig. 6. Now file or turn the head of a short cap screw to fit the hole in the top of the base with about .005" play. This temporary stud is used to center the table while the various punch holes are marked.

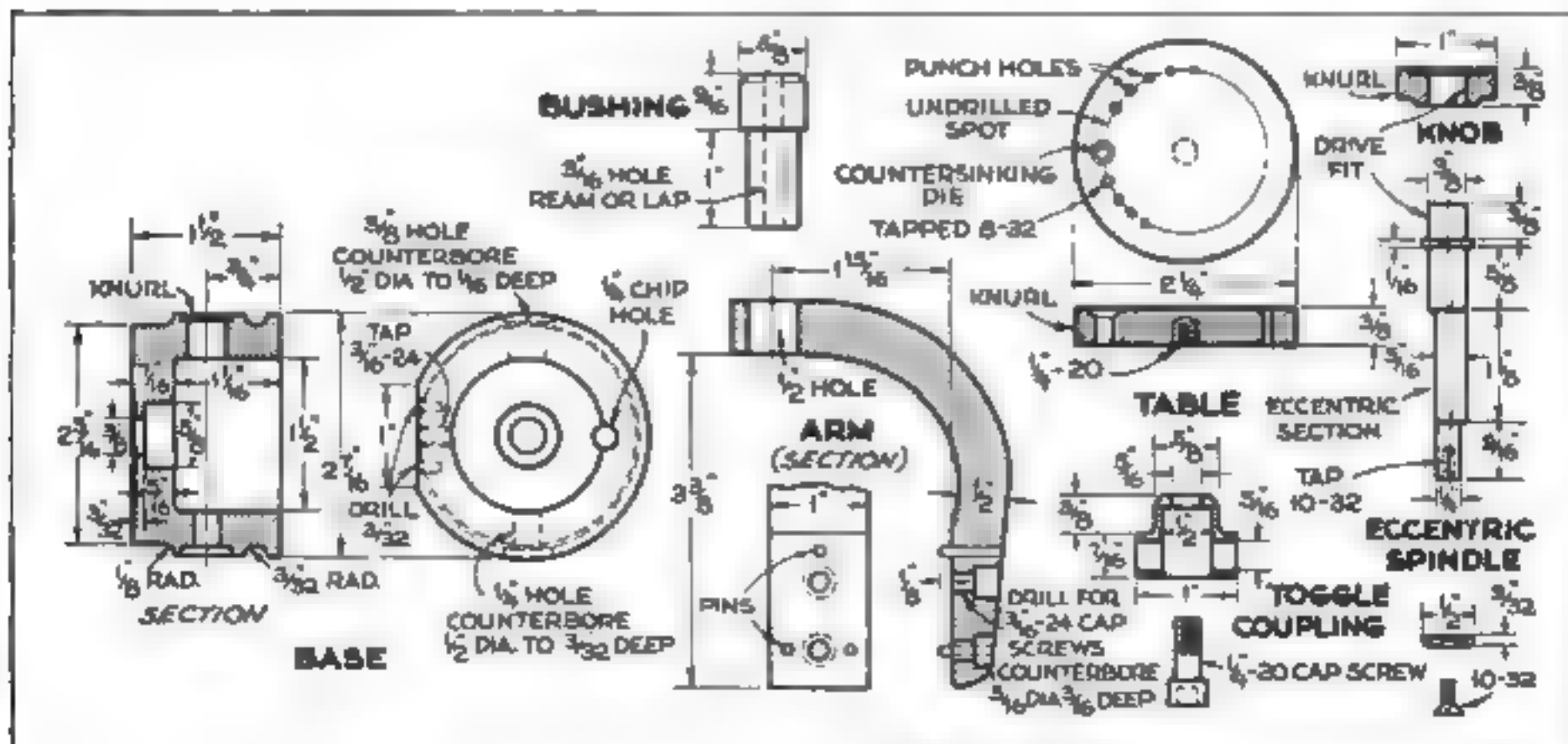
From $3/16$ " drill rod machine a centering tool and punch with a 60-deg. point, as

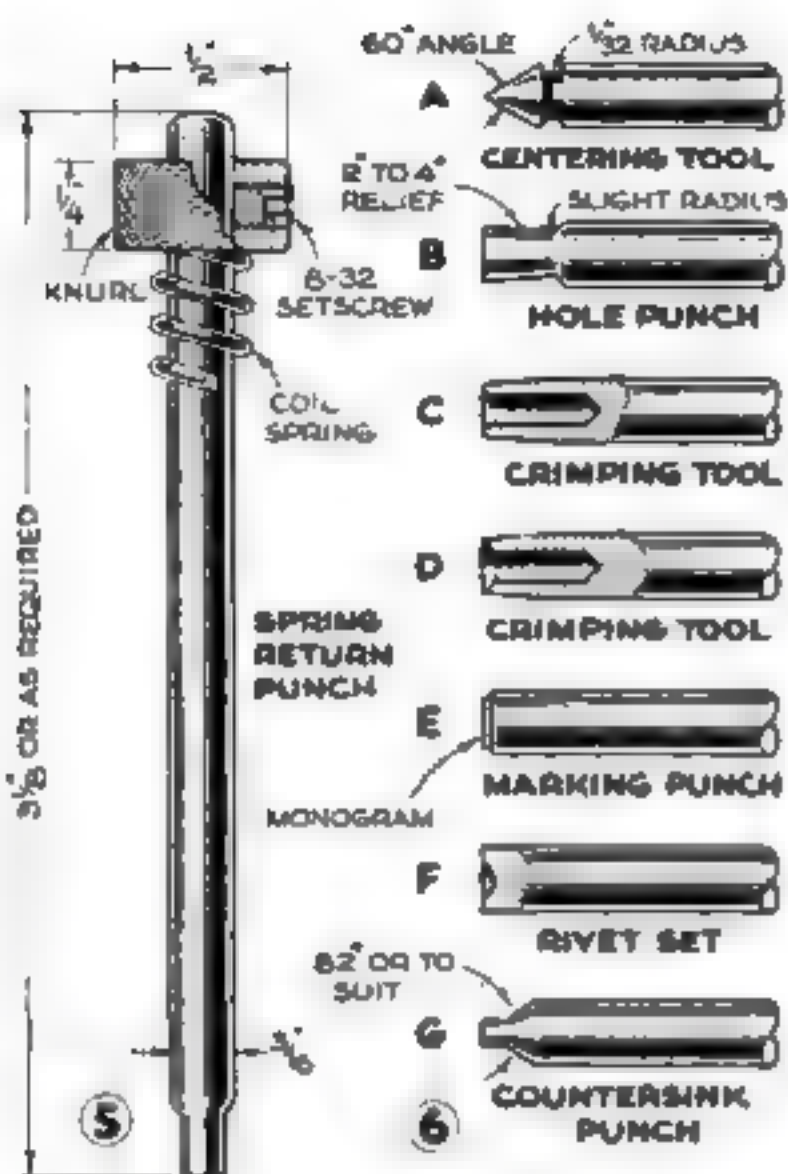


Line up a hole with the centering tool while the table is unlocked; then lock the spindle, insert the desired punch, and strike smartly

shown in the drawing on page 192. Since drill rod varies slightly, make sure it will slide snugly through the bushing. Harden the punch for about $1/2$ " at each end.

With the arm in position and the punch in the bushing, center the table and temporary stud on the base. Use the punch, as in Fig. 7, to mark the positions of the various holes near the edge of the table, leaving one space blank for special jobs. Make an assortment of sizes to suit your needs; it is a good idea to have them correspond to standard wire or fractional drill sizes. The maximum should be $3/16$ ". In drilling (Fig.





8), first use a bit a few thousandths under-size, and then ream with the correct size drill. Harden the table and grind both surfaces true. If one table does not contain enough holes, make a second one. Lay out the chip hole also with the centering tool.

Machine the coupling from steel that can be hardened. The exact length of the bolt connecting it to the table is determined after the eccentric spindle has been made. Machine this spindle from drill rod. The $1\frac{1}{2}$ " length that fits in the toggle-coupling hole is slightly off center so that rotating the spindle will exert a pulling action on the coupling and lock the table. This off-center diameter can be formed by chucking the piece off center in a four-jaw chuck. The fit between the toggle coupling and table is very loose to permit exact alignment.

Figure 9 shows a collar and coil-spring arrangement that will draw the punch back automatically after it has been struck. The setscrew should rest in a shallow hole near the head of the punch.

At left is shown a useful assortment of punch tools, but others may quickly be made as required if a supply of punch blanks is kept on hand. Harden punches at the ends.

Brazing Torch Constructed of Pipe Fittings Uses Domestic Gas

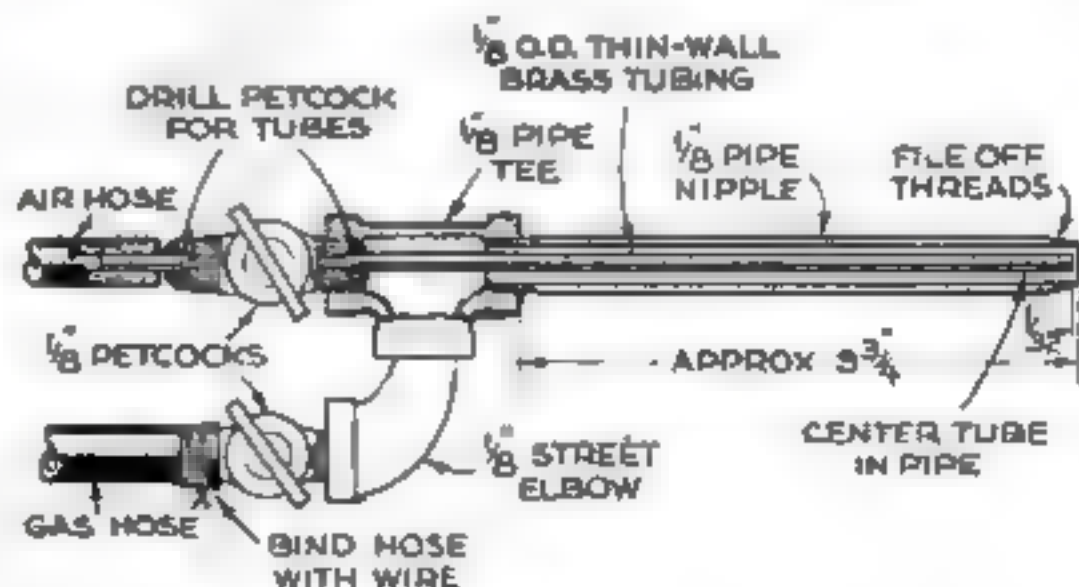
LIGHT brazing and silver soldering are possible with a torch built of pipe fittings and a length of small tubing, as shown below. Its air supply may be a shop air line, a paint-spray outfit, or even a hand pump.

Drill out both openings of one petcock $\frac{1}{8}$ " deep, as indicated, to take two lengths of $\frac{1}{8}$ " o.d. thin-wall brass tubing, and solder the pieces of tubing in place. One piece should be just long enough to support a rubber air hose, while the other should extend to $1/32$ " from the end of a pipe nipple screwed into the side of the tee opposite the

petcock. Fit an elbow on the leg of the tee and attach it to a second petcock connected with the house gas supply.

About 8 lb. air pressure is required for the torch. To put the tool into use, first turn the gas on full and ignite it; then turn the air on slowly until you get a roaring blue flame. Should you fail to get a good flame with the air on full, cut the gas flow slightly. Correct valve settings can be determined with practice.

Because gas will burn at the mouth around the air blast instead of popping back when the flame is low, the torch is particularly useful for fine work.—JACK WILLS.



HANDSOME leather handles that will last a lifetime are an inexpensive luxury that will be especially appreciated by the craftsman who enjoys working with hand tools. They are particularly suitable for the handles of hammers, carving tools, hand punches, screwdrivers, bench knives, hunting knives, and gunsmith's tools, and are serviceable also on the cranks of machine tools.

You can get enough leather for most handles from the soles of an old pair of shoes, though new leather is easier to work. This may be obtained in many instances from scraps at a shoe-repair shop, or a small piece of sole leather may be purchased from a dealer in shoe or leather supplies.

Leather for a handle such as that shown here on a punch is cut in the shape of washers with a $1\frac{1}{8}$ " and a $1\frac{1}{4}$ " hole saw. These saws work fast in a drill press. The pilot holes are reamed with a $\frac{5}{16}$ " bit to fit snugly on a $\frac{3}{8}$ " by 4" carriage bolt, and the washers are put on and cemented to the bolt and to each other with the larger ones where the handle is to have the greatest diameter. Use a quick-drying, water-resistant household cement.

Fit a metal washer at the end, leaving about $\frac{3}{8}$ " of the threaded end of the bolt



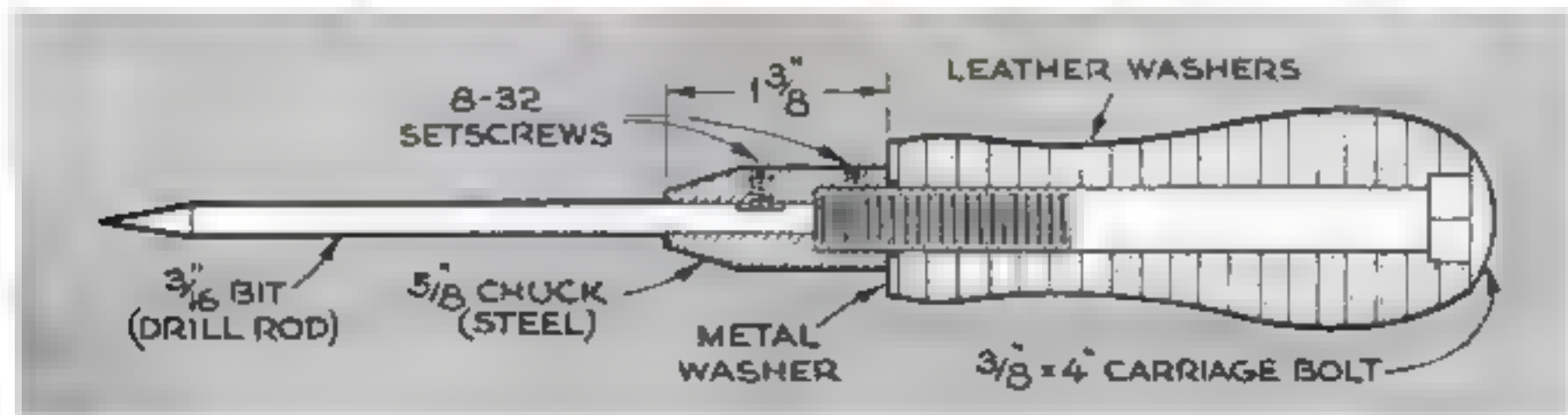
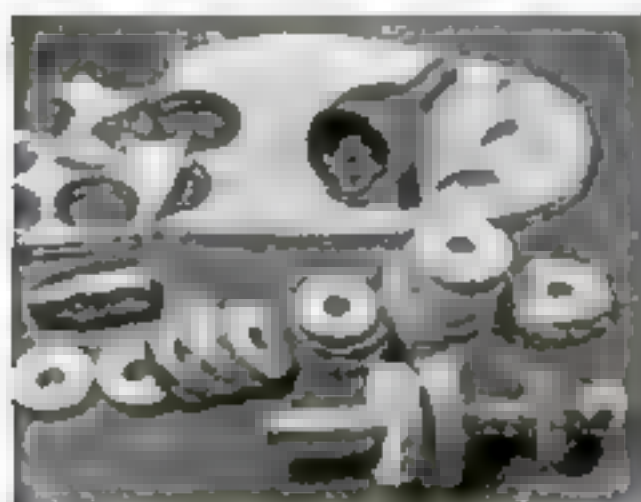
DELUXE TOOL HANDLES MADE OF LEATHER

projecting, and tighten a nut against it to clamp the leather pieces together until the cement sets. After this, the leather may be shaped by clamping the handle in a vise and using a wood rasp and abrasive paper; or, if you have a lathe, it can be turned. Chuck the threaded end, being careful not to damage the threads, and support the bolthead in the hole in the tailstock spindle, using plenty of lubricant. Run the lathe at a fairly high spindle speed, and turn with a tool ground for steel or aluminum or with ordinary wood-turning chisels.

Finish with tan or neutral shoe wax buffed to a sheen. Such polishing should be repeated once or twice a year.

The ferrule shown was turned from a short piece of $\frac{3}{4}$ " round steel bar and threaded to screw on the projecting end of the bolt. Putting in setscrews, as shown, permits the handle to be used with several tools.

This handle construction is adaptable to any kind of core. That for a knife should be flat, and it could be drilled and tapped for a small bolt to hold a metal cap. For strength in a hammer handle, use a large wooden core and thin washers. Anchor the leather to the core for twist tools like screwdrivers, by using a rectangular core.—W. E.





HOLDER ADAPTS FLEXIBLE SHAFT TO LATHE USE

By C. W. WOODSON

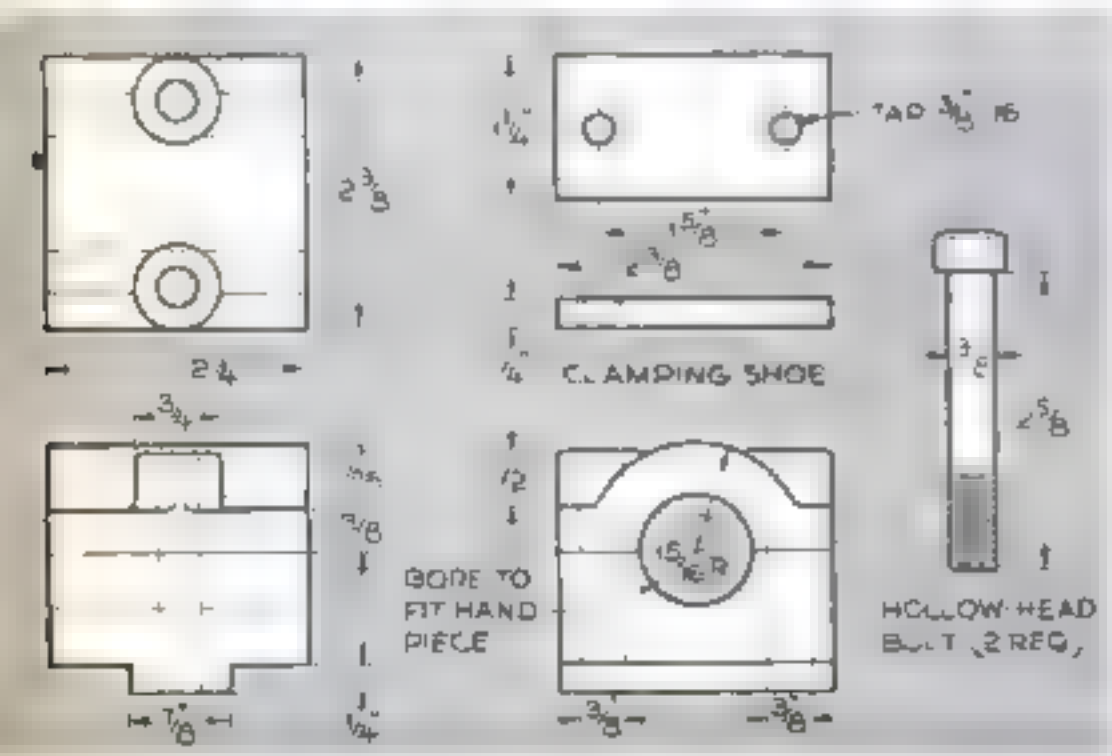
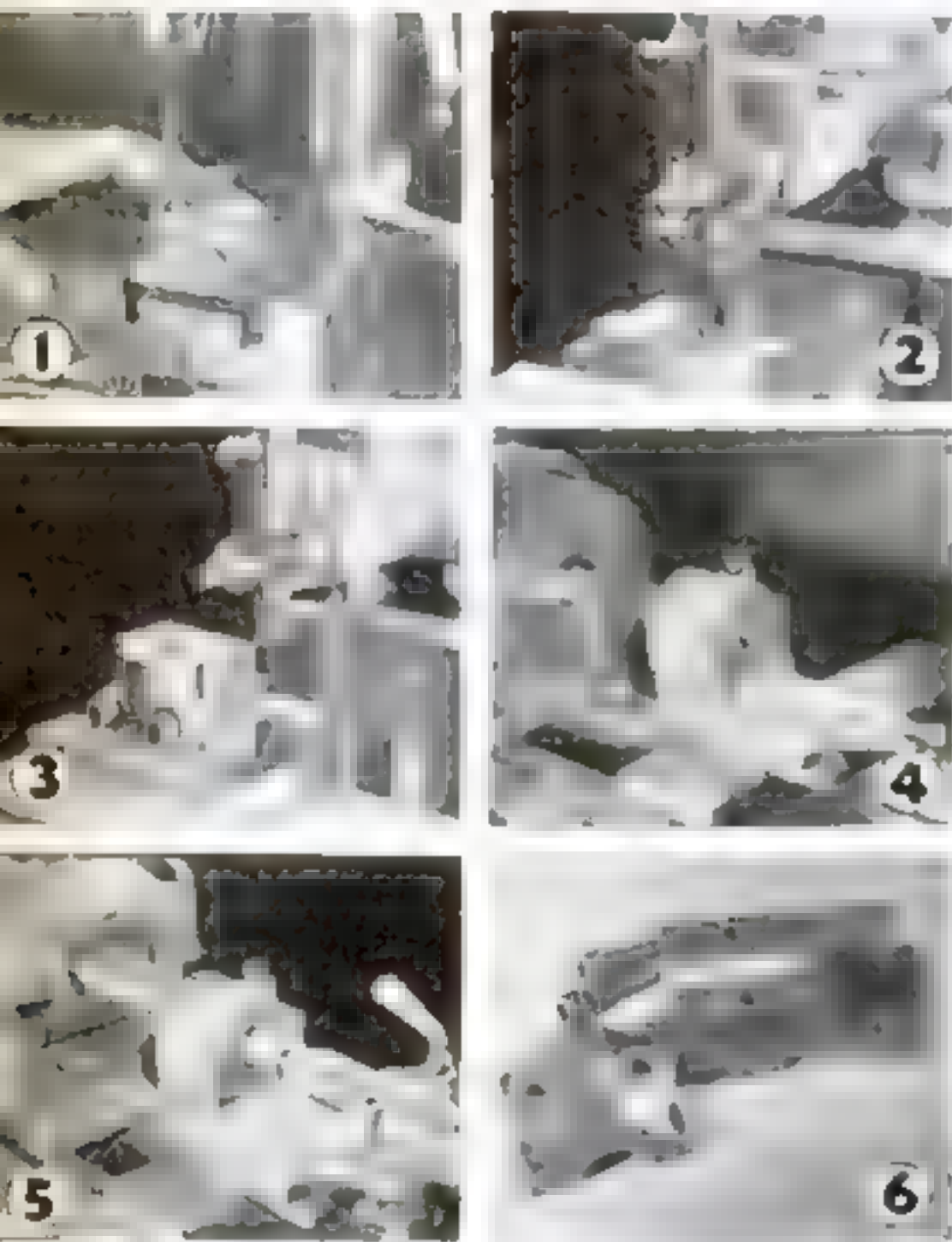
ADVANTAGE can be taken of the high spindle speeds of the flexible shaft for internal drilling and grinding operations of considerable accuracy by mounting this handy accessory in the lathe. A holder that will support the flexible shaft at exact lathe-center height will be required.

The holder shown in use at the top of this page, in process of construction in the series of numbered photographs, and in the drawing gives rigid support to the hand piece. This is thus mounted under full control of the compound rest, the cross slide, and the carriage feed of the lathe.

With the flexible shaft running at high speed, and the work chucked and turning over slowly, very accurate results can be obtained in small-hole drilling, internal grinding, sharpening prick punches, grinding lathe centers, and similar operations.

A holder that will give good service may be made of two steel blocks. When it becomes possible to obtain castings again, or if you have the facilities for making castings yourself, you may prefer to work with castings of some fine, hard metal like the gray nickel-iron alloy of which the holder shown was made. In this case it will be necessary to construct patterns of soft wood, following the dimensions in the drawings. Vary these dimensions, of course, to fit the lathe that will be used, making sure that the flexible shaft will be supported at exact lathe-center height. This requirement will be met automatically if the methods illustrated in the photographs are followed.

Mount the piece for the cap in a shaper or in a four-jaw lathe chuck and take a smooth facing cut on the bottom; then drill the two clamp-screw holes, as in Fig. 1. Next, machine the base of the holder on the top and bottom, as shown in Fig. 2, taking great care to bring the casting to exact lathe-center height when it is set in place on the compound rest. Clamp-screw holes are then drilled in



the base with the cap serving as a jig. The two parts are clamped together, as in Fig. 3, and a facing cut is taken across one end. This is necessary for the accurate laying out and starting of the hole for the flexible shaft. A steel shoe, shown with the finished parts in Fig. 6, is cut to fit the tool-post slot in the compound rest, and holes are drilled and tapped in it for the clamp screws.

The entire holder is then mounted in the lathe, care being taken to center it accurately between the ways with the cross-slide

feed. Drill a $\frac{1}{4}$ " hole through at the horizontal split between the base and the cap. Open this hole out with a large drill (Fig. 4) and bring it to final size with the boring bar mounted between centers (Fig. 5), feeding the work to the cutter with a fine power feed. This assures finishing the hole at exact lathe-center height. When the flexible shaft is then clamped in place and used for drilling, it will be accurately aligned. The motor can be hung at a convenient spot over the tailstock of the lathe.

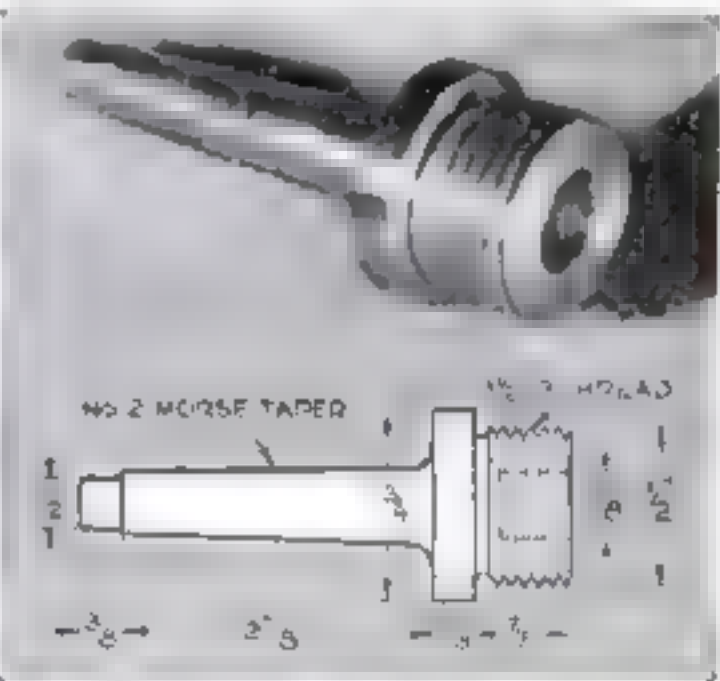
Threaded Center Provides Tailstock Mounting for Lathe Work

ADDITIONAL operations are possible with a single chucking in the lathe, thus speeding the completion of a job, when a chuck, faceplate, or other equipment usually fitted to the headstock can be mounted on the tailstock as well. This is possible with a threaded lathe center like that shown in the photographs and drawings below.

Such a useful accessory can be made easily from a $4\frac{1}{2}$ " length of scrap steel bar, or it may be built up by driving the tapered shank of a discarded drill into a small steel blank from which the head can be turned to duplicate exactly the threaded nose of the headstock spindle. With the piece in use, work can be transferred from the headstock to the tailstock without being removed from

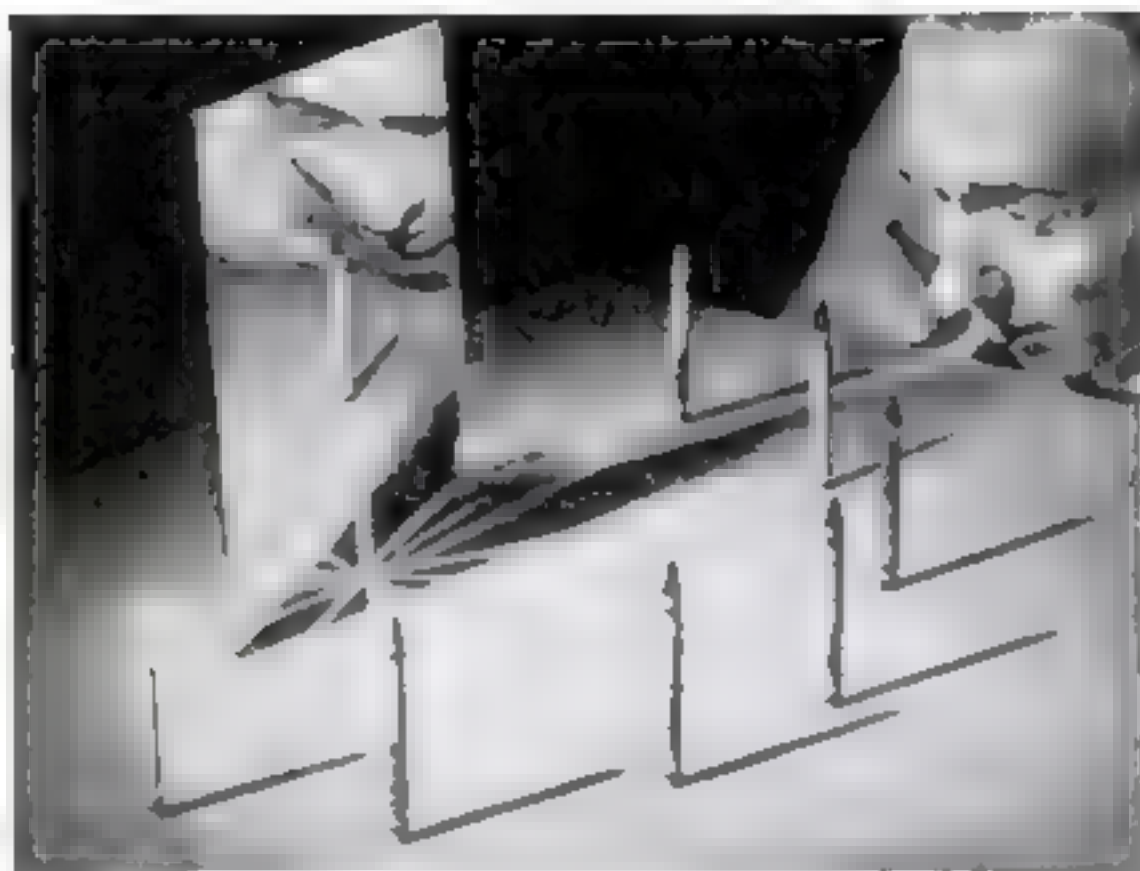
the chuck or faceplate and without its location being disturbed, thus eliminating the necessity of rechucking and the consequent loss of time required for truing.

If the piece is to be made from a steel bar, chuck the stock in the lathe and turn the No. 2 Morse taper, as shown in Fig. 1, taking care to get a perfect fit for the tailstock. Remove the piece from the chuck, slip the tapered shank into the headstock spindle, as in Fig. 2, and turn the head to the dimensions shown in the drawing. Then, supporting the piece with the tailstock (Fig. 3), cut threads to take the various headstock fittings, duplicating exactly the threads on the nose of the headstock spindle of your lathe.—C. W. W



HOME EXPERIMENTS WITH

LOOKING AT A MIRROR from one side, you see, not yourself reflected, but an object off to the other side. You can demonstrate what this angle of reflection is by standing crayons equally spaced in a semicircle and tracing lines from them to the center of a flat mirror. Sight across any crayon and take notice of the color of the one you see reflected; then find its position in the semicircle, and you will see it is at the same angle from the plane of the mirror as the one across which you sighted. For example, as you look at the photo at right you see the mirror from across the second crayon from the left. Note that the one reflected is the second from the other end.



HOW MUCH LIGHT IS BENT as it passes through a medium depends on the index of refraction—the ratio of its velocity in a vacuum to that in the given medium. To compare liquid refractive indexes, cover a square bottle with black paper, cut a disk on one side, cross the hole with narrow paper strips for reference, and make a $1/16$ " slit on an adjacent side. Fill the bottle to the horizontal strip and direct a light through the slit to hit the cross at the center. Mark the amount of refraction and try other liquids. A drop of milk may make reading easier.

WHEN REFRACTION bends light at such an angle that it can't escape from a medium, we have a phenomenon called total internal reflection. A startling demonstration of this can be made with a glass of water and a test tube in which a pencil has been placed. Lower the test tube into the water and look at it from the side, and the tube will be as transparent as ever. But look into the glass from the top while you hold the test tube at an angle and, as if by magic, that part of the tube under the water will appear as opaque as if

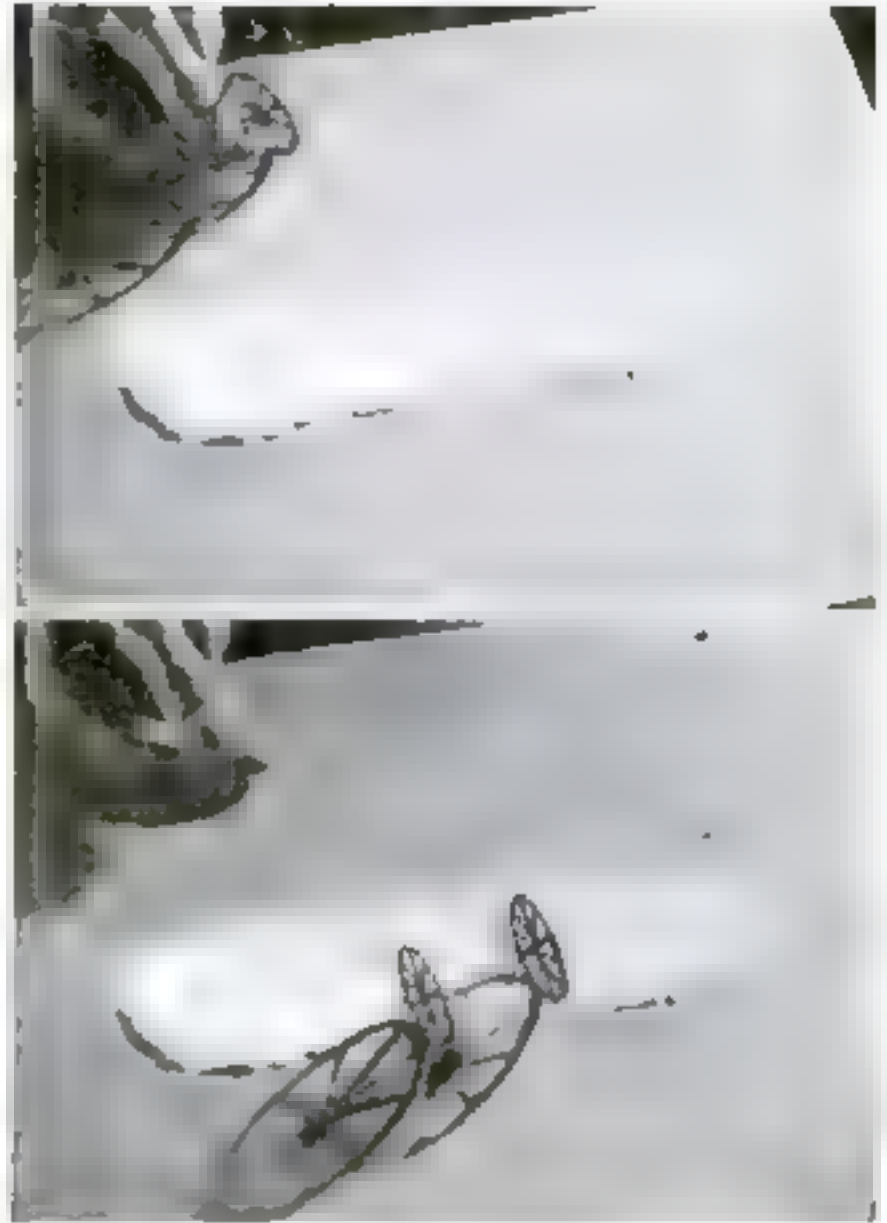


it were filled with quicksilver. The pencil in it will be completely invisible, as shown in the photo at right above, for the water will have bent the light at such an angle that it can't enter the air in the tube. Put water in the tube, and it becomes transparent again.

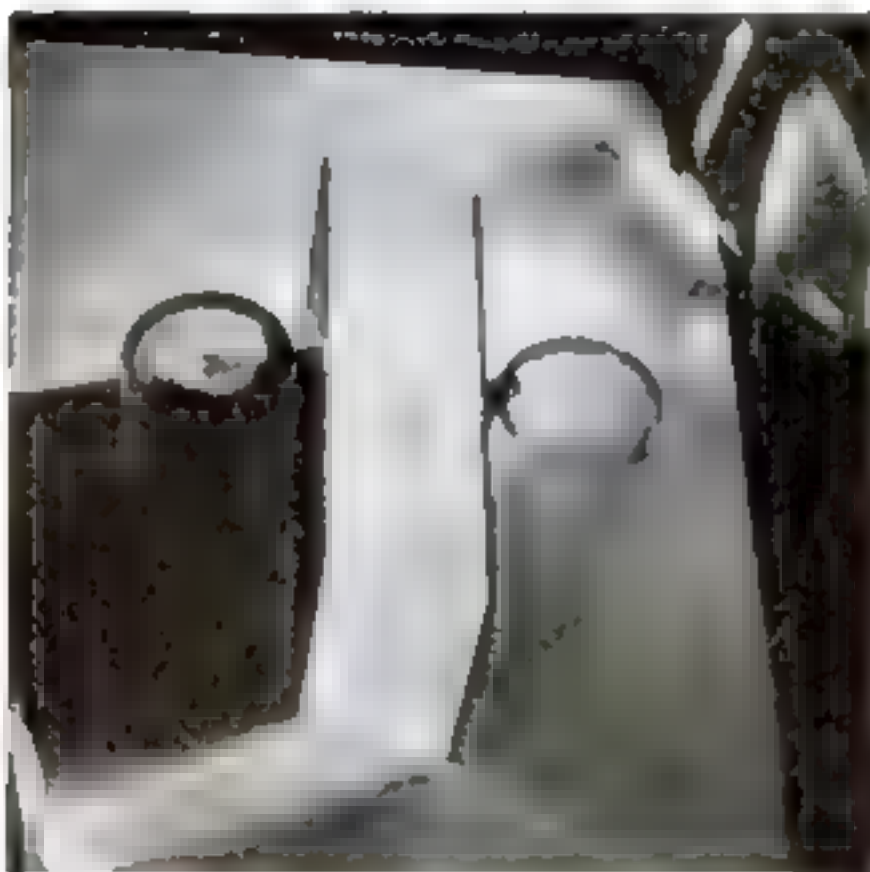
REFLECTION AND REFRACTION

WHY LIGHT IS BENT as it passes from one medium into another can be illustrated by a simple mechanical stunt. Spread a thin layer of salt, sugar, or fine sand in a strip across a smooth board, as shown in the photos at right, and let it represent glass, water, or some other refracting medium. Then use a pair of wheels and an axle from a toy wagon to represent a ray of light.

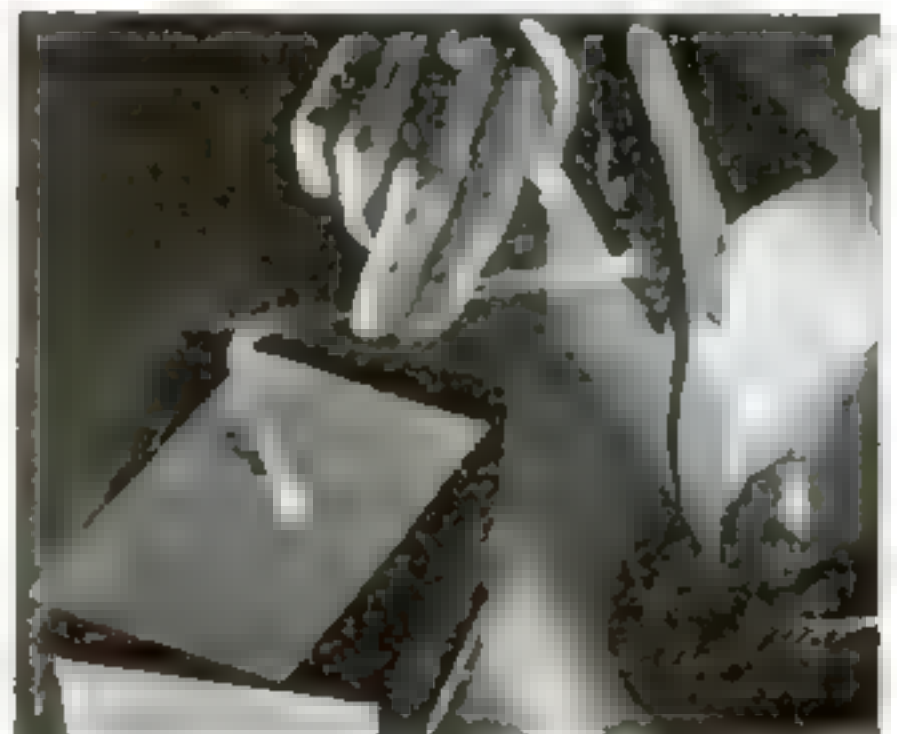
Now tilt the board slightly so the wheels will roll down at right angles to the strip of salt. They will continue across in a straight line. Let them roll obliquely, however, and the wheel that reaches the strip first will be slowed by the resistance of the salt and will swing downward from its line of travel. Then, when the second wheel hits, it also will be retarded. When the first wheel emerges from the salt, it will swing back toward the original line and, by the time the second wheel clears the salt, they will be again traveling in the original direction. A dense medium similarly slows down and deflects a ray of light.



YOU CAN PIPE LIGHT to any point by holding one end of a bent glass tube or rod against a hole in a mask over a lamp. Viewed anywhere except at its other end, the tube hardly appears luminous. How the light gets around the curve is explained by refraction, that is, by repeated reflections that so bend it at the surfaces between the glass and air that it can't escape. This is the principle of the recently developed piping of light through transparent plastic and glass bars for microscopic, industrial, and medical examinations.



TWO PARALLEL MIRRORS set up facing each other and with the ends staggered, as shown in the photo above, demonstrate the principle of piping light in a transparent tube, their opaque reflecting surfaces acting much the same as refraction does in the tube. Let light from a slit fall at an angle on the extended end of one of the mirrors. It will be reflected to the other mirror, and then, since it can't escape as long as the two mirrors face each other, it will be reflected back and forth between them until it reaches the open end, where it may be caught on a card that serves as a screen.



Getting Acquainted

By KENNETH M. SWEZEY

HALOGENS, or "sea-salt producers," is the name well given to a family of nonmetallic chemical elements that includes fluorine, chlorine, bromine, and iodine. Salts of all these elements do exist in the sea. Sodium chloride, which is table salt, and salts of bromine are taken commercially from sea water, and not so long ago most of our iodine was obtained by heating seaweed ash with sulphuric acid and manganese dioxide. Fluorine compounds, however, are generally found as the minerals fluor spar (calcium fluoride) and cryolite (sodium aluminum fluoride).

All four elements are so active that none occurs free in nature. Fluorine, a pale, greenish-yellow, corrosive gas, is indeed the most active of all known elements. This limits its commercial use, but its compounds are valuable. Cryolite is an essential flux in the production of aluminum.

Small quantities of fluorides are found in healthy bones and teeth. Hydrofluoric acid is used for etching and frosting glass.

As this remarkable acid "eats" glass avidly, it must be stored in wax or rubber. It is made commercially by heating calcium fluoride and sulphuric acid in a platinum retort and dissolving the distilled gas in water. The acid can be produced in the home laboratory by means of a chemical reaction, and the fumes can be made to etch glass.

With the help of a pair of pliers, shape a small dish from a piece of lead sheeting or a piece cut from lead pipe. Put 6 grams of the common insecticide, sodium fluoride, in the lead dish and carefully stir in enough concentrated sulphuric acid to make a thick paste. **CAUTION:** Perform this experiment in a well-ventilated room, and do not inhale the fumes as they are irritating and **POISONOUS**. The acid, too, is very corrosive and will burn painfully.

Immediately after stirring in the sul-

phuric acid, place over the dish the glass plate to be etched, first having prepared the glass with a thin coating of paraffin scratched through with the name or design you wish to etch. Leave the glass over the fuming chemical for about 30 minutes.

The ability of hydrofluoric acid to dissolve silicon dioxide (ordinary sand) and form silicon tetrafluoride, or "sand gas," provides the basis for a simple test for metallic fluorides. Put a little of the suspected chemical in a test tube, add a pinch of sand and some strong sulphuric acid, and heat the tube very gently. If a metallic fluoride, such as calcium, sodium, or potassium fluoride, is present, a

Active chlorine generated in this setup displaces bromine in potassium bromide in the horizontal tube, the bromine next drives out the iodine in potassium iodide, and this is then trapped on starch paper



with the HALOGENS

drop of water held in the fumes will turn white since, dissolved in water, silicon tetrafluoride gas forms a whitish silicic acid.

Chlorine, a greenish-yellow gas slightly darker than fluorine, is the next most active halogen. Because of its many important uses it has been treated in a separate article (P.S.M., Dec. '42, p. HW440).

The third member of the family, bromine, is a dark, reddish-brown, fuming liquid. Its name comes from the Greek word *bromos*, meaning "bad smell." The fumes are extremely POISONOUS—so much so that they are employed as a disinfectant and as a war gas. Bromides are used widely in photography and as nerve sedatives. Vast quantities of bromine, derived from sea water, are used to make ethylene dibromide, a vital ingredient in antiknock gasoline.

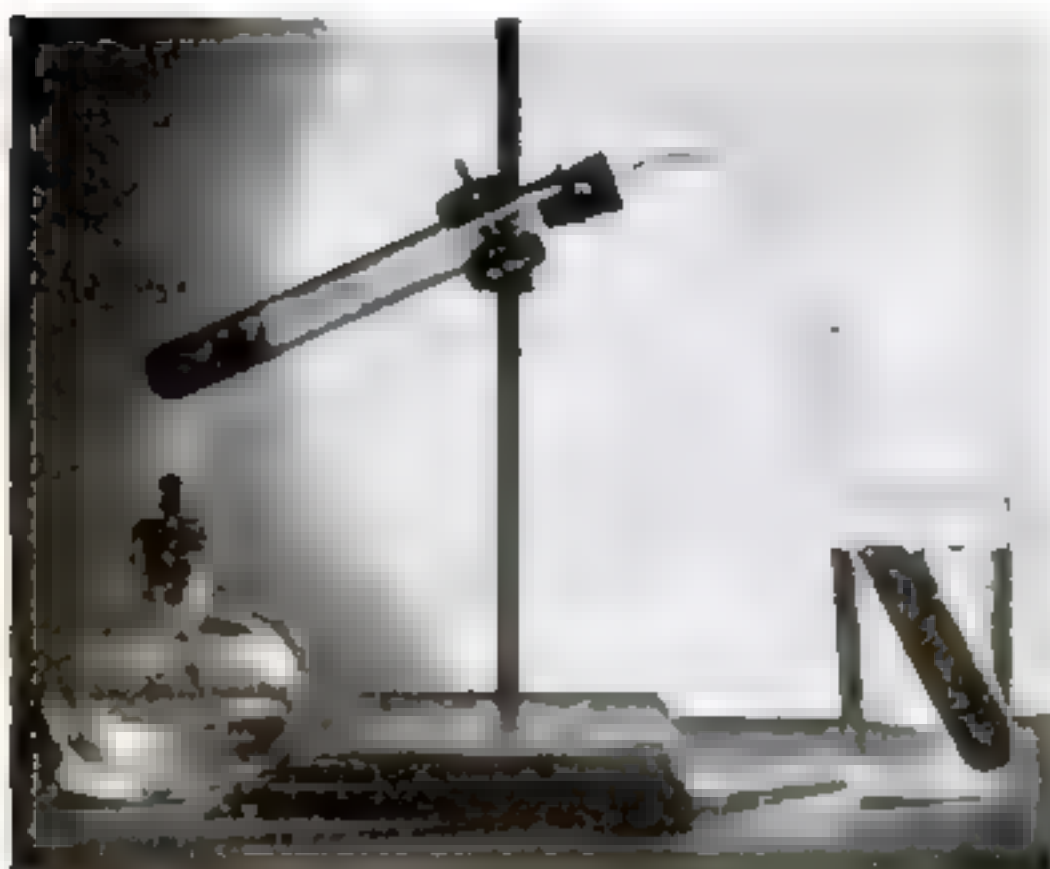
To produce bromine, mix 1 gram potassium or sodium bromide with 1 gram powdered manganese dioxide and put it in a test tube. Add 2 ml. sulphuric acid to 1 ml.

water in another test tube and, after the mixture has cooled, add it to the powder.

Now set up your tube on a stand, as shown in the photo at the left below. A bent delivery tube attached to the test tube through a one-hole stopper is then led into another test tube half filled with water and kept cool in a glass of cold water.

Heat the mixture very gently, being careful not to boil it through the delivery tube. Dark fumes will pour through the apparatus, dissolving in the water in the collecting tube and coloring it a reddish brown. Pure bromine is dangerous to touch or smell, but this diluted bromine is safe to smell cautiously and will not injure the skin if washed off promptly.

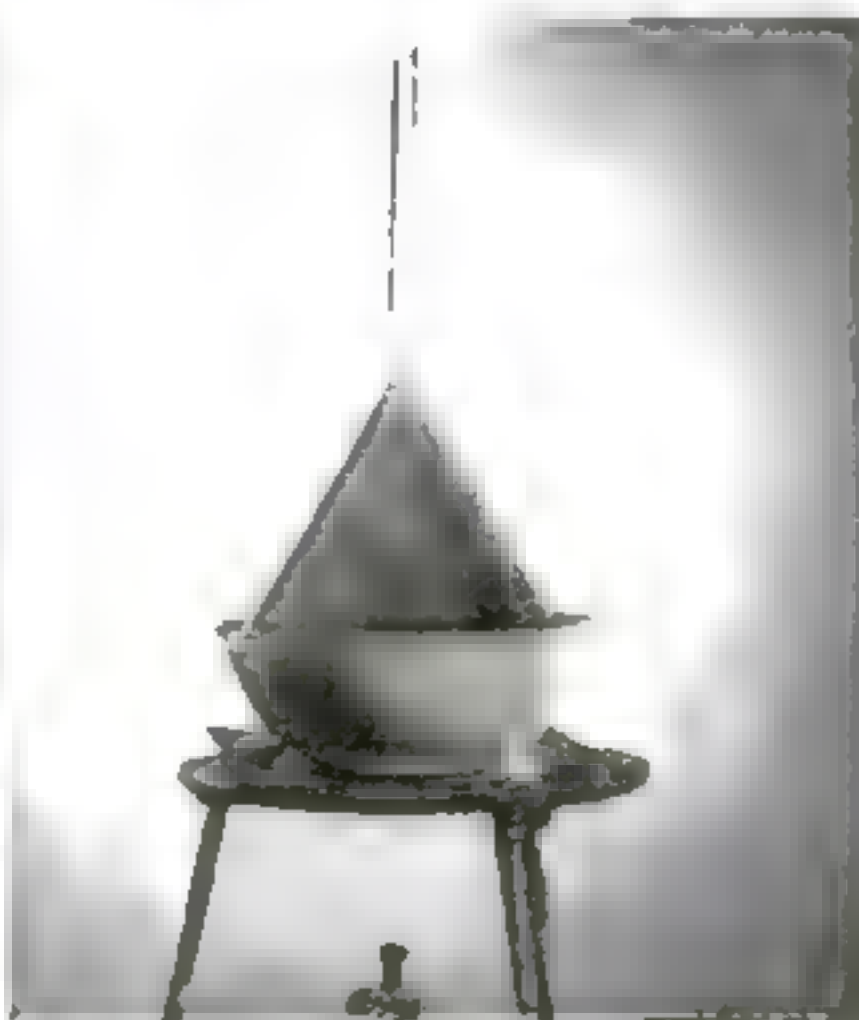
One test checks both for bromine and for the fourth member of the halogen family, the familiar iodine. Dissolve a few grains of the test substance in a third of a test tube of water. Add $\frac{1}{2}$ " carbon disulphide or carbon tetrachloride. It will sink to the bot-



Bromine, though corrosive and having poisonous fumes, is made safely in solution. Heat gently a mixture of a bromide, manganese dioxide, and sulphuric acid, and dissolve the fumes in water

Iodine is also made by heating one of its salts with manganese dioxide and sulphuric acid. Use an evaporating dish with a cold funnel over it to condense the violet fumes, as at the right above

Beautiful steel-gray crystals of iodine collect in the funnel. This process of vaporisation and condensation is called "sublimation" by chemists

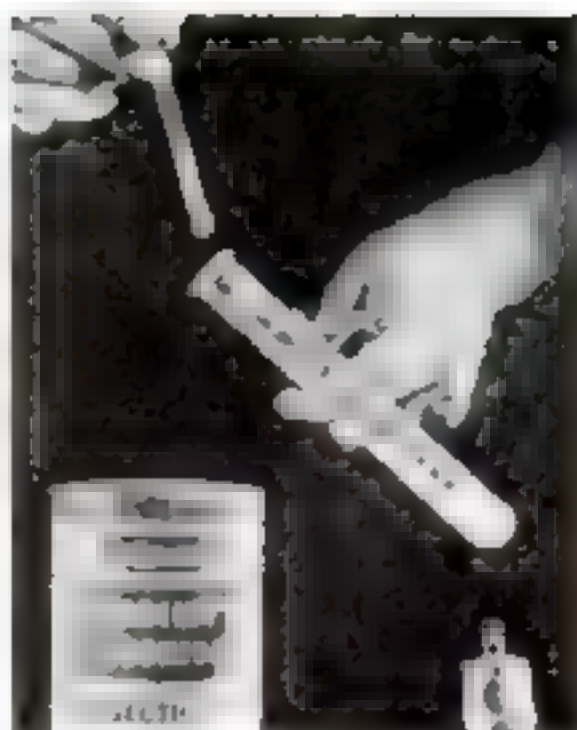


tom. With most bromides or iodides, both liquids will remain water white.

Now, add a few drops of slightly acidified chlorine water (a little acid in a chlorine bleaching solution) and shake the tube vigorously. If a bromide is present, the carbon disulphide at the bottom of the tube will be colored the typical reddish brown of bromine; if it is an iodide, the color will be a beautiful violet. The more active chlorine replaces the rival halogen in its compound. This is in principle the way bromine is extracted from sea water.

Although everyone is familiar with the brown liquid tincture of iodine (a solution of iodine in alcohol), pure iodine, a steel-gray crystalline solid, is seldom seen except by chemists. Make it like bromine, but use a beaker or an evaporating dish with a cold funnel or a dish containing cold water over it to condense the vapor. Use the same proportions of chemicals as you did in making bromine, substituting sodium or potassium iodide for the bromine salt, and heat the mixture with a very small flame. Dense clouds of violet vapor will arise and condense on the cold receptacle, leaving after a few minutes a pattern of hundreds of beautiful crystals of iodine. They may be scraped off and used in experiments. Oddly enough, iodine will turn directly from a solid to a vapor before it melts, and then it may be condensed back into a solid by cooling the vapor. This complete process is called "sublimation."

Because chlorine has a greater affinity



Fluorides heated with sulphuric acid and common sand give off a gas that turns a drop of water white by formation of silicic acid

for the metallic portion of a compound than has either bromine or iodine, it will free both of these substances from a metal and join with the metal itself. Bromine, having a greater affinity for metals than iodine, will set iodine free.

You can demonstrate vividly the relative activity of these three elements by generating chlorine in a flask and leading it through a bent delivery tube into a large horizontal tube containing several grams of potassium bromide held in place by a cotton plug on each side and, several inches farther on, a like portion of potassium iodide similarly held between cotton plugs. A small piece of blotting paper, moistened with a starch solution, is placed in the far end of the horizontal tube to act as an indicator. Then a bent tube leading from the far stopper is connected with an inverted funnel the mouth of which dips just beneath the surface of a strong sodium hydroxide solution that will catch excess gas. The setup is shown on page 198.

Add hydrochloric acid through the thistle tube to a water solution of ordinary household chlorinated lime in the flask. As chlorine from the reaction passes into the horizontal tube, bromine will be freed from the potassium bromide, and its brown fumes will fill the tube between the two sets of plugs. Driven on by the pressure of the chlorine, the bromine will penetrate the potassium iodide, freeing iodine, the vapor of which will react with the starch paper, turning it black—a sure test for iodine.

Sodium fluoride mixed with sulphuric acid in a lead dish gives off poisonous fumes that can be used to etch glass. Scratch the design in a coating of paraffin on the glass and hold the glass over the fumes



Recording the Saipan Fight on Wire

VIVID battlefield sounds and realistic combat action, forming a permanent first-hand record of the 13-day struggle for Saipan, have been brought to radio listeners by Lieut. Loyal (Larry) B. Hays, Marine warcaster, with the assistance of T/Sgt. Keene Hepburn.

Lieutenant Hays, formerly a San Francisco broadcaster and station operator, and Sergeant Hepburn, who was before the war a mechanically minded salesman from Pennington, N. J., shoved off with the Marine-Army-Navy amphibious force assigned to the Saipan job and started recording as soon as their transport sailed. They put their apparatus on the flying bridge of a patrol craft on D-Day. On the third day after, they were able to get it ashore.

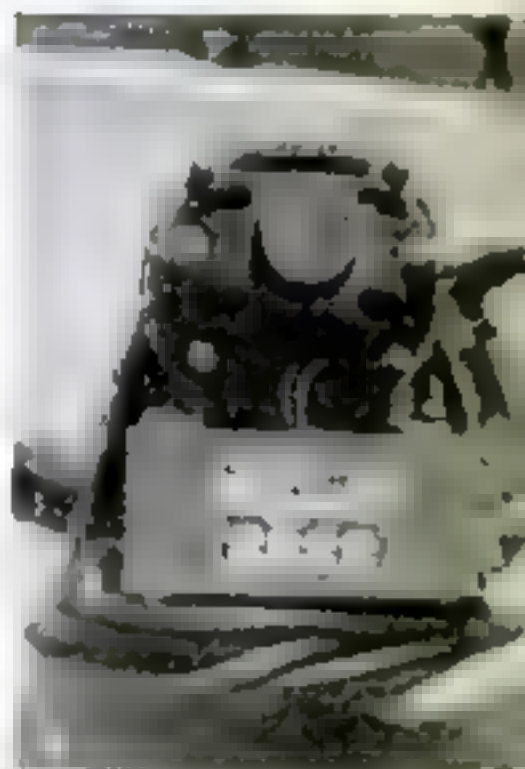
Apparatus used aboard ship was a 45-lb. wire-recording unit hardly larger than a portable typewriter. It was developed by the Armour Research Foundation and manufactured by General Electric Company. Sound, recorded on acetate-coated wire sensitized as it passes over an electromagnet, is later "dubbed" (re-recorded) on disks. Operation is by ship's power or by two 6-volt batteries and a motor generator.

To get close-up recordings of the fighting on the island, Hays and Hepburn mounted a Presto Model Y recording disk, a turntable, an amplifier, two 6-volt batteries, and a motor generator in an open jeep. The sun was so hot that the electrolyte in the batteries boiled, and Hepburn had to shade the apparatus with a shelter half to keep the acetate on the disks from melting. To make matters worse, choking dust sifted onto the disks, caused surface noises, and kept the needle from cutting. Operation became somewhat easier a few days later when the equipment was transferred to a covered command car.—ARTHUR GRAHAME.

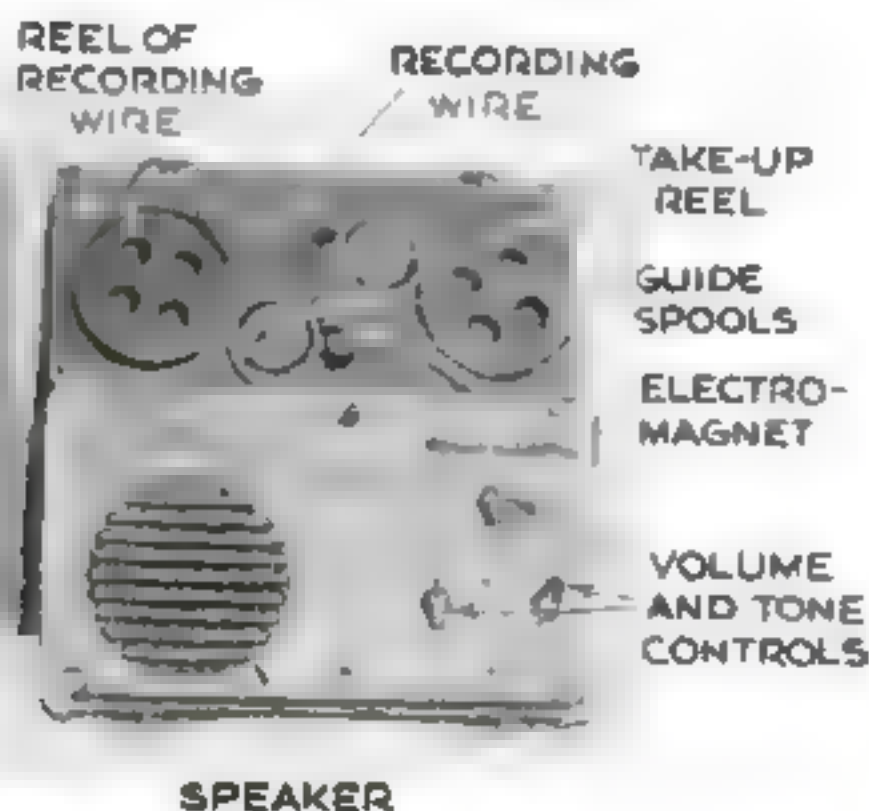


Lieut. Larry Hays records impressions of a Marine officer in the Saipan fight

At right a motor generator run by batteries for power in operating Hays's apparatus. At left is a wire recorder used on shipboard during the landing

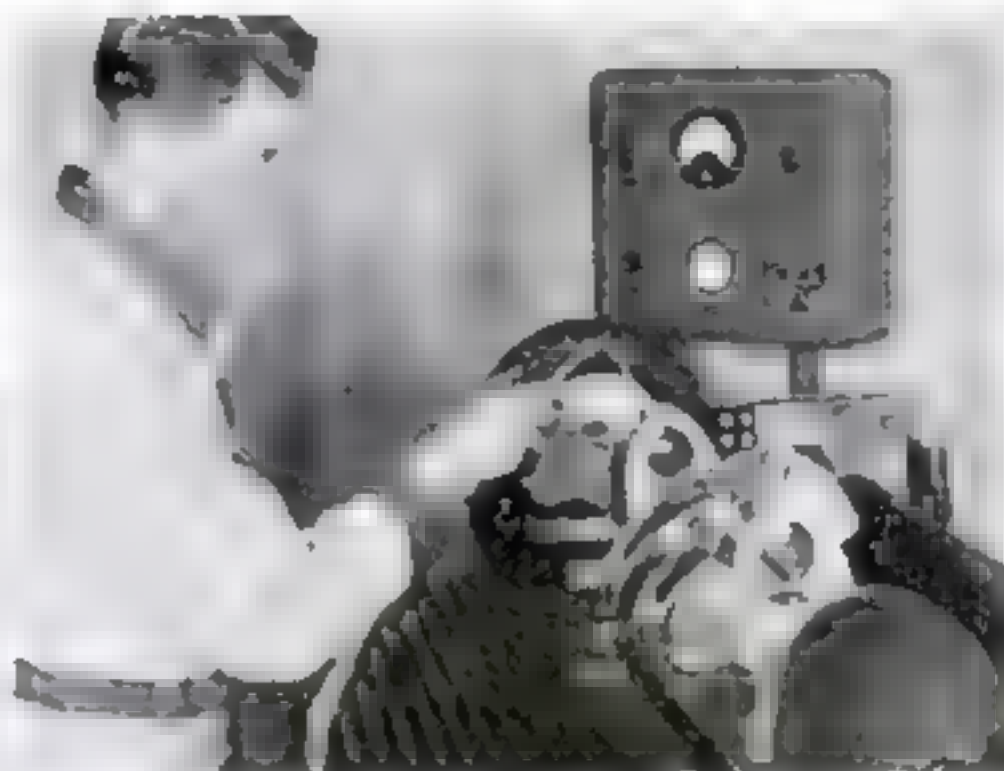
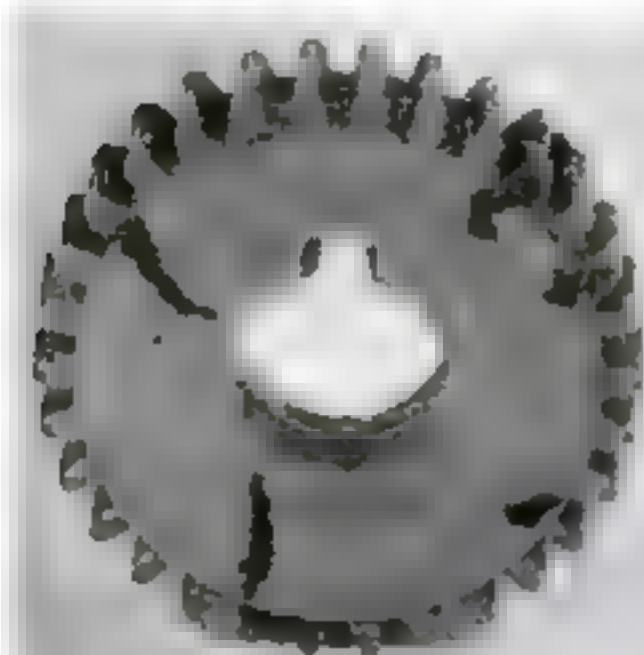


Batteries were put quickly under the tropical sun. Two 6-volt ones were employed at a time

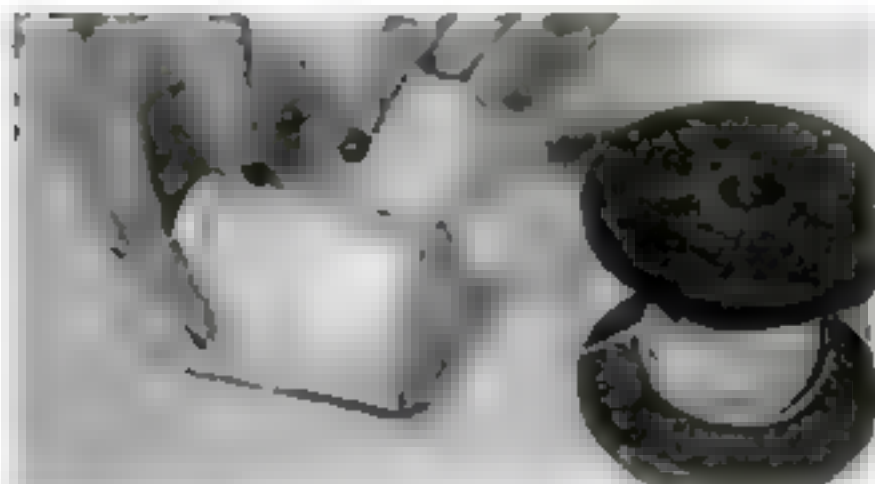


HOW MAGNETIC FIELDS

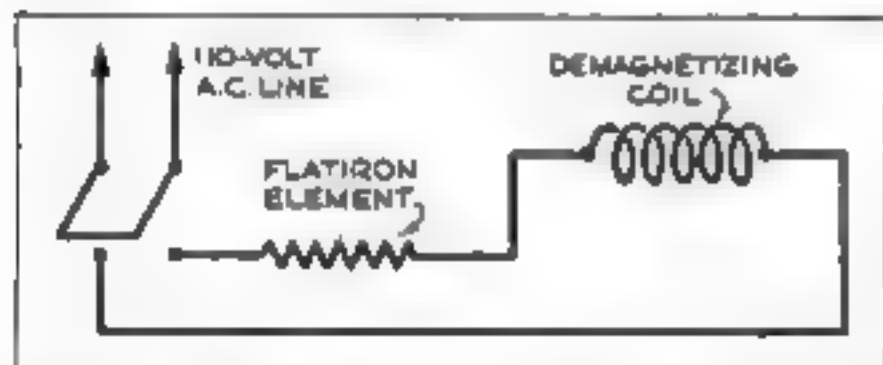
Simple home apparatus can be set up to duplicate the methods used in industry to spot defective parts.



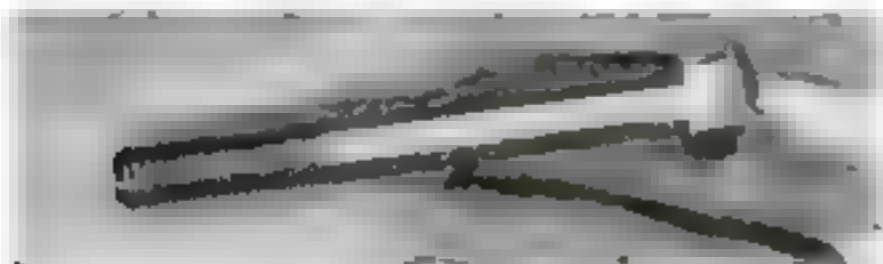
Attracted by poles set up in magnetized metal by interior gaps, iron oxide reveals the presence of unseen defects. Above, indicator mixture is flowed on in a test machine made by the Magnaflex Corp.



One coil wound on a cardboard form serves both for demagnetizing a test piece and for bipolar magnetizing. Below, the demagnetizing circuit



Before testing, this bolt appears structurally sound and capable of standing considerable stress



By TRACY DIERS

ONE of the foundations for the structural safety of power-diving planes and other metal bodies subjected to great stress was laid many years ago when some men experimented with pieces of magnetized iron and iron filings suspended in paraffin oil. When the magnetized pieces of iron were placed in the oil bath, the filings promptly lined themselves up in fascinating patterns on the surface of the iron.

A laboratory curiosity at that time, this little magnetic toy has developed into the technique known as magnetic inspection of metals—an inspection system that has been largely responsible for an amazing reduction in plane crack-ups and for the structural safety of metal in general. How effectual such tests are can be seen by comparing the photo of the steel bolt at the bottom of this page with the two of the same bolt on page 204. In the first photo, the bolt appears to the eye to be quite solid and free from defects; but magnetic inspection reveals serious cracks, as shown in the other two photos by the dense black collection of iron-oxide particles over the flaws. Similarly, the gear and nut shown at the top of this page reveal markings that indicate defects not suspected before magnetic inspection.

If you have a storage battery, you can

REVEAL THE INVISIBLE

experiment in your home laboratory or basement workshop and reveal for yourself many hidden flaws and fatigue markings. You will be particularly interested in seeing how small iron and steel gears, chisels, and even bolts and nuts stand up under the searching eye of magnetic inspection.

Two preliminary steps will be necessary. First, the object to be tested must be cleaned thoroughly with dilute hydrochloric acid. Second, since most metals contain some residual magnetism, this must be destroyed.

You will need, therefore, a demagnetizing coil, which can be made by winding four layers of No. 20 or No. 22 magnet wire on a cardboard coil form about 2" in diameter and 3" long. This coil is hooked up in series with a flatiron, as shown in the wiring diagram on the facing page, and is connected with ordinary household A.C. The flatiron element will limit the current through the coil to about 6 or 7 amp.

With the switch to the demagnetizing coil closed, the bolt or other piece to be tested is passed very slowly into the center of the coil, where it should be allowed to remain for a full minute, after which it should be removed as slowly from the other end of the coil. An adequate check for residual magnetism can then be made by bringing the piece close to a compass. As a general rule, if it causes the needle to move before it has been brought to within 2", the demagnetizing process must be repeated.

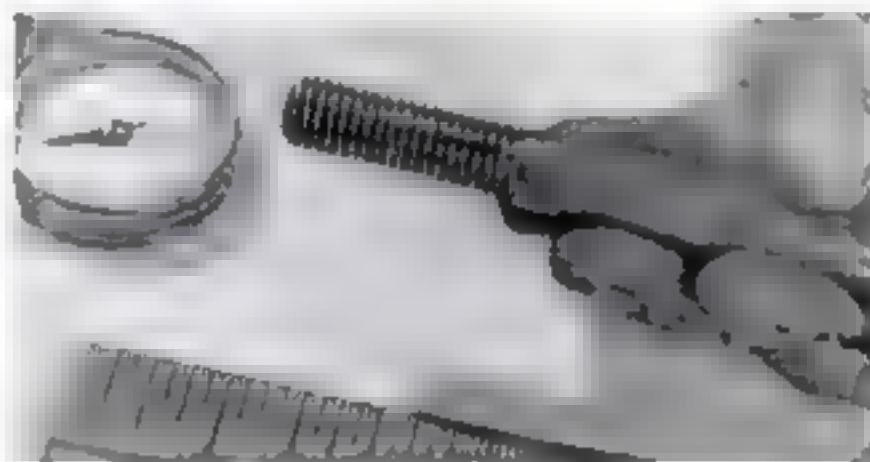
When the preliminary steps have been completed, the specimen should be magnetized in two ways for inspection. One method employs circular magnetism, and tests for flaws running lengthwise; the other, the more familiar bipolar magnetism, will reveal the presence of crosswise breaks. Either test may be given first, but it is essential that the piece be passed through the demagnetizing coil between the tests.

For the circular-magnetism test, attach two heavy clamps to the piece being inspected and connect them to a storage battery as shown in the wiring diagram at right. Heavy leads, such as No. 10 or No. 12 wire, should be used, and the connections should be made as tight as possible, since the voltage is low.

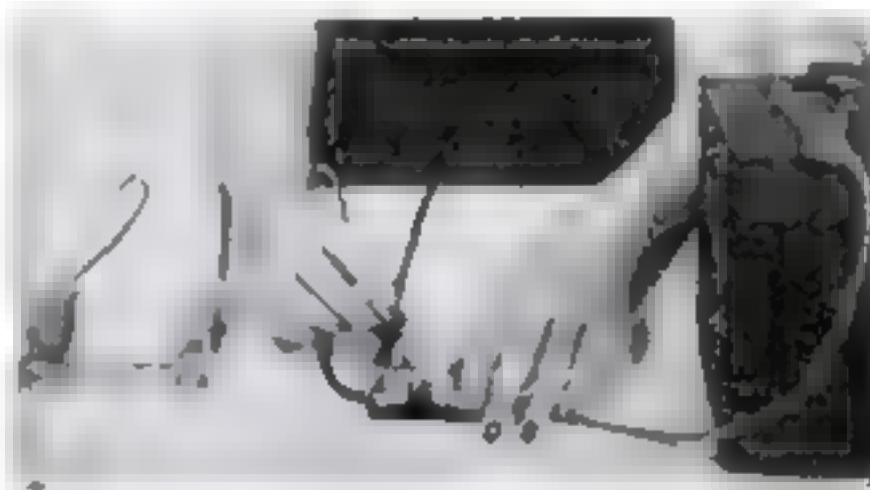
The current drawn, however, will be very high—150 to 200 amp.—and the switch therefore should be closed for no longer than one second in order not to deplete the battery. Personal precautions should also



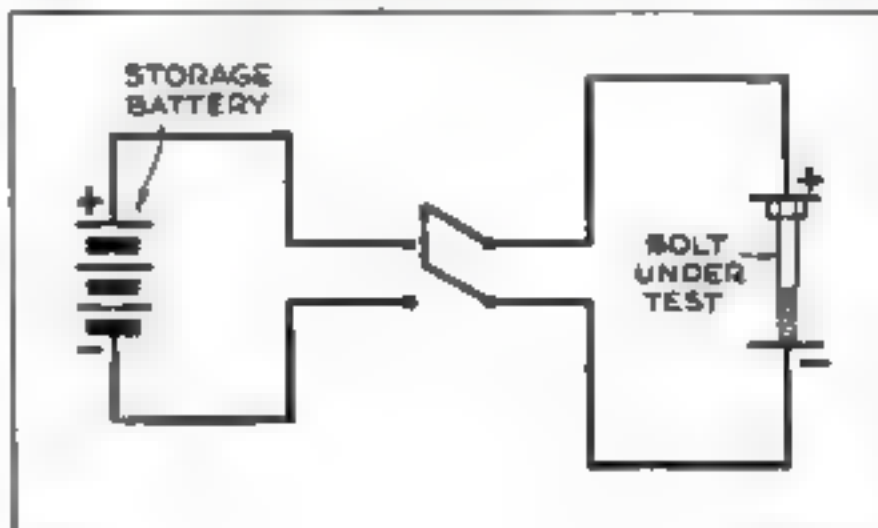
After being cleaned with hydrochloric acid, the bolt is put through the demagnetizing coil for removal of residual magnetism; afterward it is tested (below) by being held close to a compass



Next, clamped as shown below in a circuit with a storage battery, the bolt gets a one-second charge of 150 to 200 amp. that sets up a magnetic field

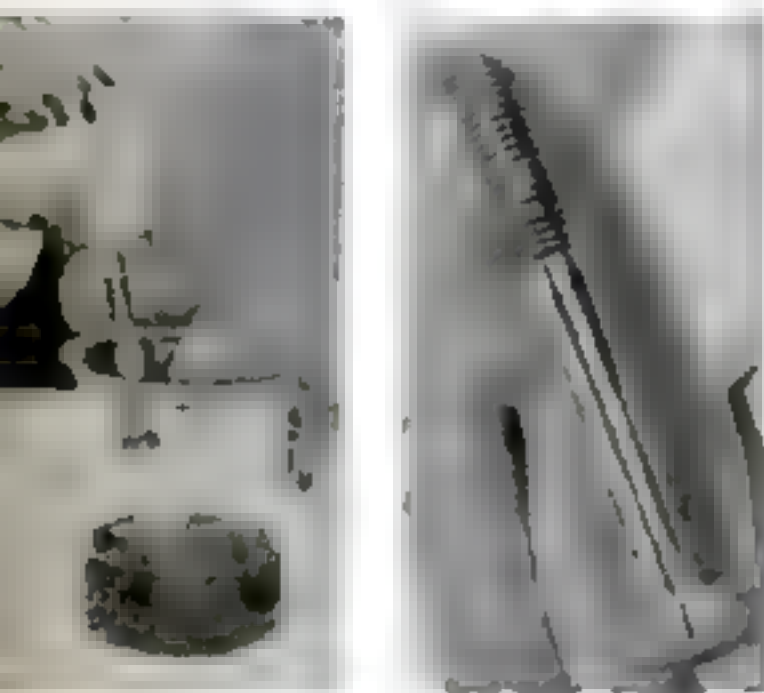


Below is the wiring diagram for the circuit. The current induces circular magnetization, which is used to show flaws running lengthwise in a piece

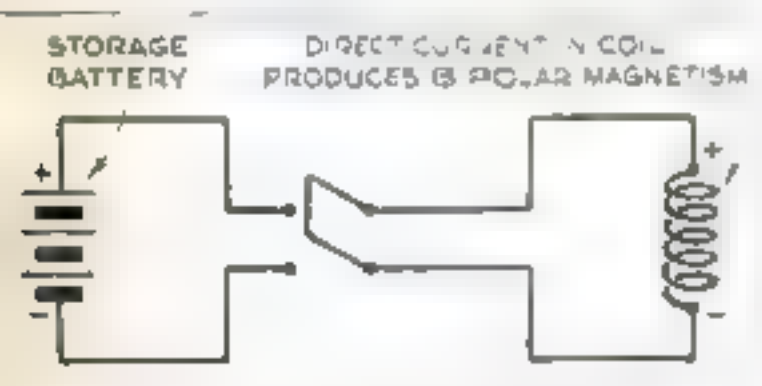




An indicator solution is made up from iron oxide and kerosene. Below, in a sound piece the magnetic field is continuous, but any cracks generate poles



For the test a circularly magnetized piece is lowered into the solution. Iron oxide will collect, as shown at the right above on the surface over any invisible lengthwise flaws present



To reveal crosswise cracks, the coil is connected as above. The demagnetized bolt is held in it a few seconds



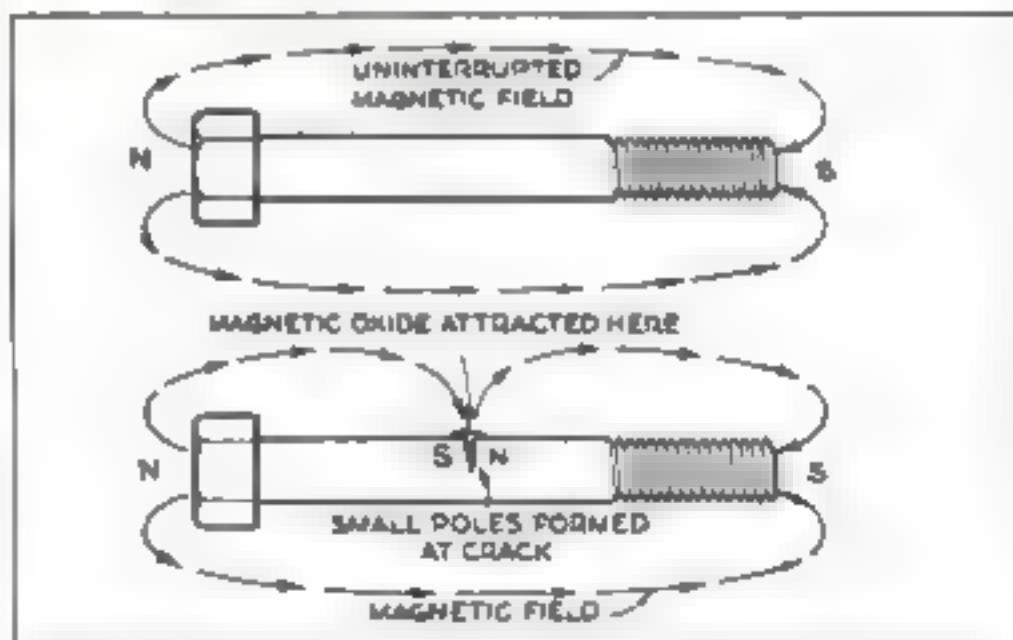
be taken when working near a high-amperage source. Don't wear a ring or wrist watch, for the high amperage, if shorted, can cause a painful burn.

Circular magnetism sets up a magnetic field traveling around inside the test piece, as shown in a drawing. If there are flaws, the field will have to jump the gaps and thus will develop poles. These in turn will attract magnetic substances just as a horseshoe magnet does, but the attraction is low, and a sensitive indicator is needed.

Such an indicator can be prepared in solution from 1 oz. magnetic iron oxide (Fe_3O_4) and 10 oz. kerosene. Grind the iron oxide into a paste with a little of the kerosene; then add the remainder. Shake the solution well before using. Lower the piece slowly into the indicator, leave it suspended for one minute, and then remove it gently.

For the bipolar-magnetism test, first demagnetize the piece. Then hook up the same coil used in the demagnetizer, as shown in the diagram below, place the test piece in the center of the coil, and close the switch for five or six seconds. This will produce a north and a south pole, as shown in a drawing. Tapping the piece may speed magnetization. The magnetic field will flow without interruption if the piece is structurally sound. Small additional poles, however, will be formed at a crack, and these will attract the iron oxide when the piece is again dipped.

Soft iron does not retain magnetism for long, and therefore does not produce as positive results as does hardened steel. When applying circular magnetism to small gears and nuts, sandwich them between heavy metal plates. Be sure to demagnetize a piece before putting it back into shop use.

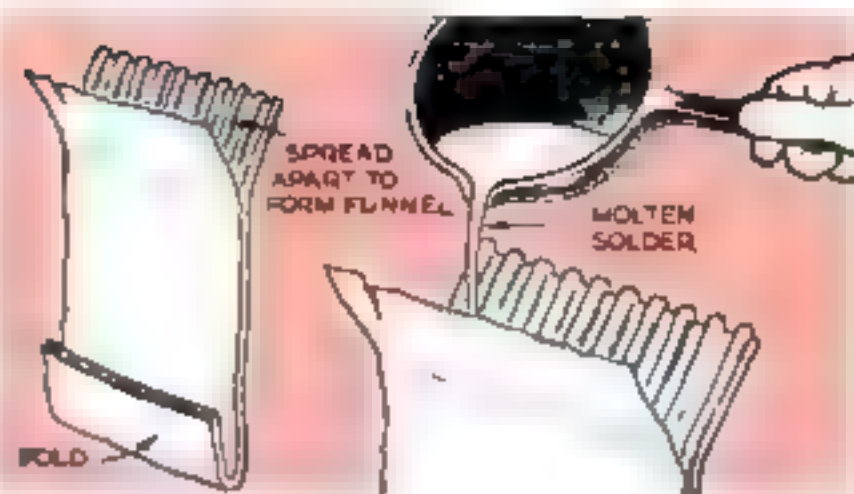


This circuit sets up conventional bipolar magnetism in the bolt, producing the familiar north and south poles. The magnetic field is uninterrupted if there are no flaws, but even an invisibly small break creates poles, which in turn collect iron oxide on the surface when the piece is tested



Wire Solder Molded in Paper

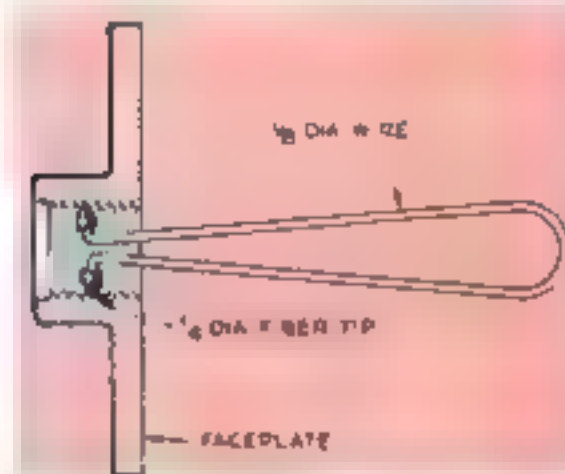
ONE method of casting solder into wire form is to use the side of a corrugated-paper carton as a mold. Fold up one end of the corrugated piece so the solder won't run out, and spread apart the other end for about 1" to form a sort of funnel. If you then pour molten solder into this mold, it will set before the paper has a chance to catch fire from the heat, and you will have handy wire solder.—ERNEST O. HEINE.



Fiber-Tipped Wire Cleans Out Threads

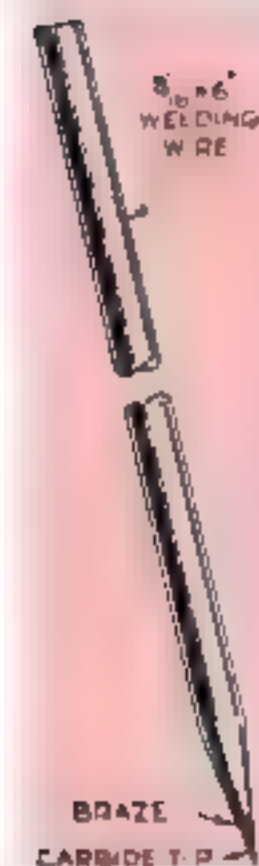
CHIPS and dirt collecting in the threads of the faceplate and chuck will often make a lathe run out of true. For a simple and efficient thread cleaner, bend a piece of $\frac{1}{8}$ " diameter wire as shown at the left, and tip the ends with points turned to 60 deg. from $\frac{1}{4}$ " diameter fiber stock. Make these tips a press fit on the wire.

In use, spring the wire together just enough to insert the points in the last thread; then screw it out. The fiber points will not become magnetized, and thus will do a better job than the wire alone.—H. D. CHAPMAN.



Lifetime Scribe Has Superhard Tip

WITH a 6" length of $3/16$ " welding steel and a small piece of tungsten carbide, a lifetime scribe can be made for marking the hardest metal and even glass. Grind the end of the welding wire to a point, and then, using a bit of brazing wire, flux, and a welding torch, braze the tungsten carbide tip on this point. A final grinding will give you a tough, sharp scribe good for many difficult marking jobs.—R. C. HARRISON.



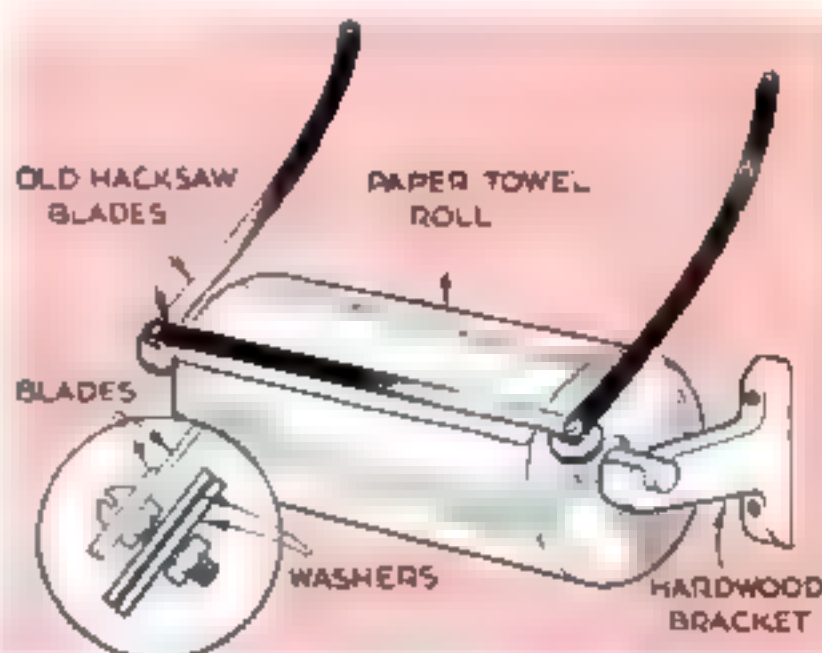
Brush Handle Opens Paint Can

BENDING and sharpening the end of a $\frac{1}{2}$ " by 2" piece of metal, and drilling it with two holes so it can be screwed to the handle of your favorite paintbrush, will give you a paint-can opener that will always be at hand when you need it. If you do much painting, such an opener might be an advantage on each brush.—J. A. DEHAAN.

Towel Rack Has Handy Cutter

THREE old hacksaw blades and two brackets, arranged as at the right, make a handy paper-towel rack for the garage or workshop. Join the blade used as the cutter bar to the ends of the other two with small bolts and draw the nuts up tight. The addition of two free washers to each bolt and a second nut drawn up only part way will provide a pair of rollers to prevent friction on the towel roll.

Saw two brackets from hardwood and screw them to the wall. Above them attach the free ends of the two blades holding the cutter.—HENRY L. DAVISSON.





Long before they fly bombing missions, the cadets at the San Angelo, Texas, Bombardier School learn how to become expert with the Bomb Spot movie camera

A frame from a movie film taken of a specially prepared Texas prairie target. At night the targets are brightly illuminated by powerful incandescent lights

Movie Cameras Spot Hits for Bomber Cadets

MOVIES keep score on the hits made by bombardier cadets at the San Angelo, Tex., Army Air Field. The men being trained to plaster the daylights out of the enemy are taught to prove their records with motion pictures.

Cadets fly in pairs, one operating the bombsight while the other mans the movie camera. When five bombs have been dropped and their hits recorded by the camera, the cadets change places and repeat the operation. Army men say that the continuing production of bombardiers could hardly be maintained if it were not for this training. A large and well-equipped photographic laboratory working 24 hours a day is an indispensable factor in developing perfection in the use of our bombsight.

Laboratory technicians keep more than 100 A-4 Bomb Spot cameras ready at all times. Camera repairmen vacuum-clean, lubricate, and lens-clean every camera every day, after which they load them with 35-millimeter film and deliver them to the operations room ready for work.

The bomb-spotting film projector, on the ground glass of which the picture taken of a bomb hit is flashed for a close scoring





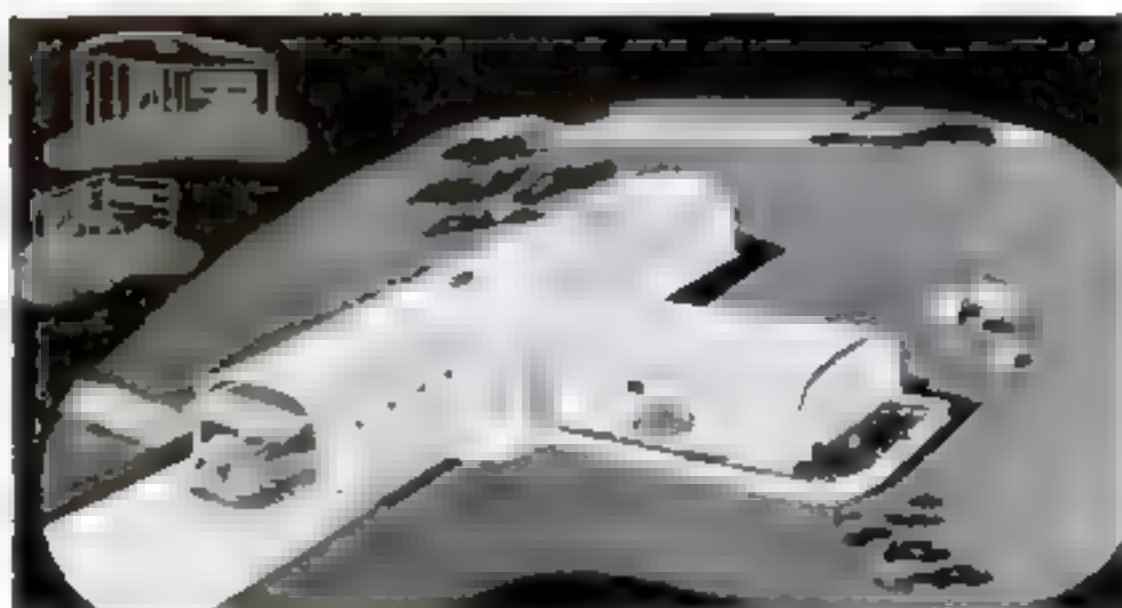
GRADES ARE DUCK SOUP to this giant General Motors Diesel locomotive on the Boston and Maine Railroad. It hauled a 3,839-ton freight train, made up of 125 cars, on a nonstop run from Boston to Mechanicville, N. Y., negotiating the steeper grades

without the aid of helper locomotives. Adding to its record for freight performance, the 5,400-horsepower Diesel whisked the heavy train over the 189 miles in six hours and 25 minutes. Formerly, the average train required 10 hours.



JEEPIE-SPEAKIE is respectfully suggested as the unofficial name for this homemade variation of the "walkie-talkie" that has been developed by a 23-year-old Air Forces sergeant. Using spare parts and radio mechanisms recovered from damaged planes, Sgt. Lee C. Ramsey, of the Victorville, Calif., Army Air Field post communications department, assembled this portable two-way radio transmitter. It was designed to be used as an auxiliary or emergency unit for field operations.

A CROCKERY HOUSE like this one will cost under \$3,000 according to the estimate of the architect. George W. Walker, Detroit industrial designer, who drew the plans and elevation, calls it a typical pattern of the ceramics house. The model contains four rooms and an attached garage, and is one of a dozen or more models that can be constructed with standard-size, production-line ceramic panels.





CORNFIELD GUNBOAT is an unofficial designation for the dummy U.S.S. *Dahlgren*, which lies where corn once grew at Great Lakes Naval Training Station. The vessel is 180 feet long at the keel, and has a 50-foot beam. Aboard her, sailors are trained in such duties as standing watch, taking turns at the wheel, using signal flags, and lowering and raising lifeboats.

BOTH PLASTIC AND ELASTIC is this house of the future, designed by Alden B. Dow and shown by him at an exhibit of the Society of Plastic Industries at the Waldorf-Astoria, New York City. Planned on generously modernistic lines, it is made with translucent walls and roof, and is so constructed that the owner can add units to it when, as, and if he desires. The model is seen below.



OVER 30,000 MILES of telephone "drop wires" are being painted with asphalt to conserve their rubber insulation. With the aid of this moving paint box, developed by Bell System engineers, a painter can cover as much as 40 feet of wire a minute. The painting will extend the life of the wires three years or more.

We're Shooting the Best

(Continued from page 131)

shortage of copper forced a conversion to steel, methods and machines were devised quickly to cold-forged a steel disk into a cartridge case in a matter of moments. Now the copper situation has become easier, and a gradual shift back to brass for cartridge cases of all calibers, except .45, is being made.

When cartridge cases and shells are finished they are sent to loading plants. TNT is melted and, while still warm, poured into H.E. shells. After it has hardened, a cavity is bored in it, and a metal container holding the booster charge is inserted. The bursting charge of an A.P. shell in powder form is loaded by pressing machines. For fixed and semifixed ammunition, the propelling powder is loaded into the cartridge cases, the fuses inserted in the shells, and the components assembled into complete rounds. For separate-loading ammunition, the loaded projectiles are sent to ammunition depots, where they are assembled with propelling-powder charges from bag-loading plants.

No ammunition is of more value nowadays than aircraft bombs. A year ago we were making them at the rate of 20,000 a day. Since then production has been stepped up sharply to keep pace with the demands of our ever-growing fleets of bombers.

The general-purpose, or demolition, bomb is the type most used by both Army and Navy air forces. Its cylindrical body of forged or welded steel has strong but relatively thin walls. Its filler of high explosive accounts for about half its total weight. Nose and tail fuses are used. A 250-pound bomb will destroy any building but a skyscraper; a 2,000-pound bomb exploding in the water 25 feet away will either sink or seriously damage a battleship.

Semi-armor-piercing bombs have heavier cases than the general-purpose type, and contain relatively less explosive. The 500-pound size will liquidate a tank, and the 1,000-pound bomb will penetrate the side or deck armor of warships below the battle-cruiser class. Big seacoast-mortar shells have been converted into armor-piercing bombs. On a direct hit they will penetrate battleship armor, but they aren't popular with airmen because they contain so little explosive that near misses with them do only slight damage.

Fragmentation bombs are used against personnel, motor transport, and similar targets. When they explode they shatter into more than 1,000 steel fragments which have velocities as high as 4,000 feet a second.

For low-altitude attacks they are fitted with parachutes which insure that they will hit nose-first, and which also enable the plane dropping them to get away before they burst.

Chemical bombs, weighing from one to 100 pounds, are filled with smoke-producing or incendiary compositions.

Torpedoes, used by cruisers, destroyers, PT boats, submarines, and planes, are the deadliest weapon of sea warfare. Gyro-steered and propelled by turbine engines powered by compressed air, steam, or gases from burning alcohol, they contain more than 5,000 parts, and are the most complicated, the most expensive, and the most difficult to manufacture of all types of ammunition. Details of their design, construction, and capabilities are secret, but it may be said that they are much faster and longer-ranged than the torpedoes used in World War I, and that their war heads carry heavier explosive charges. Submarines discharge their tin fish from underwater tubes with compressed air; surface vessels launch them from deck tubes by means of an explosive charge. Airborne torpedoes are somewhat shorter than the other types, and are sturdily built to enable them to withstand the terrific shock of hitting the water after being dropped from a high-speed plane flying at a considerable height.

Depth charges are made in 325- and 650-pound sizes. Dropped from release racks, or thrown by black-powder-charged Y or K guns, they are exploded by hydrostatic fuses when they sink to the desired depth.

Submarine mines, some of them weighing a ton, are used by the Navy and by Army mine layers of the Coast Artillery organization. Loaded with high explosive, some are detonated by secret contact and magnetic devices. Controlled mines, exploded by electricity from shore stations, are used by the Army for harbor defense. The Army also uses very large quantities of 10½-pound antitank mines loaded with six pounds of high explosive.

The Navy has 38 ammunition depots and magazines, a few of the larger ones in the interior for greater security, but most of them on the coasts. After final assembly at one of these depots, ammunition is shipped to overseas naval bases or issued directly to ships.

Completed Army ammunition is assembled in various Ordnance Department depots for shipment to the theaters of operations. Overseas it is handled by Ordnance-operated ammunition - distribution systems which

stretch from the ports and beachheads to the front lines. Whenever possible a "rolling reserve" is kept on railway cars or motor trucks ready for immediate movement. Ammunition is considered the most essential item to be supplied to troops both before and during combat.

A recent innovation in the handling of ammunition by the Army is the use of a new steel container designed to give increased protection to packaged artillery rounds and powder charges. It replaces a container made of fiber and metal, which provided inadequate protection. Used cartridge cases may be sent back to the United States in the new containers—a fact that is expected to result in a higher rate of return.

ANSWERS TO SIX PUZZLERS

(See page 132)

TARGET Score of 100 was made with six shots—two on 16 and four on 17

CLOCK. $11\frac{1}{4}$ seconds. There are four time intervals from the first bong to the fifth, each interval representing $1\frac{1}{4}$ seconds. Since there are nine intervals between the first and the tenth bongs, total duration will be nine times $1\frac{1}{4}$, or $11\frac{1}{4}$ seconds.

PENNIES. Private Dugan wins, but it's a low way to make money. He simply picks up the penny nearest him and places it on top of the middle penny, making two rows of four each.

KNOTS. Numbers 1, 3, and 4 should be labeled "Knot"; numbers 2, 5, and 6 are in the "Nix" class.

STRING. The sailor unfetters himself by taking the girl's string and slipping a U-shaped loop of it under the string encircling one of his wrists. Then he puts his hand through the loop and goes back to his ship a free man.

COINS. Place one finger of your left hand firmly on the nickel. Now with two fingers of your right hand, move the right quarter an inch or so to the right. Then bring it back to strike the edge of the nickel sharply. It should not move, but the impact will be transmitted to the left quarter, making it spring far enough away so you can move the right quarter to the center.

New Process Promises Plastic from Sawdust

A SINGLE ton of sawdust will yield more than 1,000 pounds of high-grade ingredient for plastics, according to reports of a new extraction process worked out by Dr. Donald F. Othmer, Dr. Robert S. Aries, and Dr. Raphael Katzen at the Polytechnic Institute, Brooklyn, N. Y. Besides, chemical by-products will include 120 pounds of acetic acid, 60 pounds of furfural, and 500 pounds of sugar—the latter good for hundreds of pounds of alcohol.

The new plastic is described as similar to many now on the market. Reclaiming mill waste would provide a plentiful source of raw material for economical production, the developers of the process say, thus releasing more plastics for civilian use even before the end of the war.

Belated Credit

The page of U. S. Army Air Force insignia appearing on page 122 of the October issue of this magazine was reproduced by permission from AirView, a publication of the Douglas Aircraft Company. Our apologies to Douglas for the oversight by which credit was omitted.

Statement of Ownership, Management, Circulation, etc., required by the Act of Congress of March 3, 1933, of Popular Science Monthly, published monthly at New York, N. Y., for October 1, 1944. State of New York, County of New York ss. Before me, a notary public in and for the State and County aforesaid, personally appeared Geoffrey Hammond, who, having been duly sworn according to law, deposes and says that he is the Business Manager of Popular Science Monthly and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, and of the editorial and business control for the date shown in the above caption, required by the Act of March 3, 1933, embodied in Section 1103 of the Postal Laws and Regulations, printed on the reverse of this form to-wit:

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(Signed) Geoffrey Hammond, Business Manager
Sworn to and subscribed before me this second day of October, 1944. Esther E. Notary Public, Kings County, Kings Co., Clerk of N. Y. 60 Registry No. 111 + New York County Clerk's No. 118, Registry No. 67 + 6. (Seals) My Commission expires March 30, 1945.

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RAILROADIN' BY RADIO



THIS, TOO, IS BENDIX... first to bring railroads added speed, economy, and efficiency through the use of VHF Radio.

Railroadin' by radio—instant, static-free end-to-end communication . . . constant contact between train and station . . . hours saved on running time . . . service notably enhanced—these are some of the vistas opened up by the combined efforts of Bendix Creative Engineering and such progressive railroads as the Burlington, Santa Fe, Baltimore and Ohio, Seaboard, and Rock Island.

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Army and commercial plane-to-ground communication—is just as practical and valuable for railroad use.

Here is another way that Bendix, source of scientific instruments and devices to conquer time, space and human effort, can beneficially influence your life. Here, too, is an added reason for watching Bendix. There will be many more, because Bendix facilities—its 12 research laboratories, its more than 30 plants, its 3000 engineers, its experience in all modern sciences—are

focused on benefiting the largest number of people.

Today this unique organization—utilizing to the full your War Bond purchases—is concentrating on hastening victory and a return to the line, free American life we all desire. But you can't stop creative minds from thinking. Already, Bendix postwar plans have gone so far that you can expect remarkable advances in transportation, communications, industrial processes, and in the comfort and pleasures of your home.

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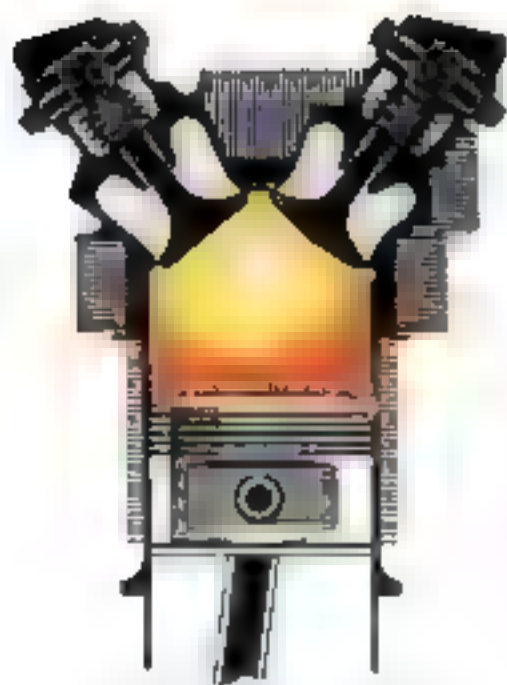
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First IN CREATIVE ENGINEERING
BUILDERS OF THE INVISIBLE CREW

Bendix



Utility or Waste?



The Wright forged-head cylinder has permitted a 15% increase in power without increase in weight.

Fuel in an engine cylinder can behave in two ways: it can burn usefully or explode and waste its energy. For best power a fuel must burn. The combustion speed of fuels has been clocked as accurately as a bullet. It's slower — only about 150 ft. per second — but this is about the right flame speed to provide proper pressures on the piston during the entire power stroke.

Detonation, which causes the familiar "knock" or "ping" in a car, results when part of the fuel burns normally and the remainder, under high pressure, explodes like a firecracker — with higher pressures, higher temperatures, and waste of energy.

The problem in engine design is to obtain maximum power at minimum consumption from a fuel without causing detonation. Ample and strategic cooling is important. So is the compression ratio and the degree of supercharging, or mixture pressure at various engine speeds. The mere use of higher octane fuel will not produce more power. The engine must be designed to take the fullest advantage of its better combustion qualities — a continuing research project in the Wright laboratories. *Wright Cyclones pay their way.*

Cyclones and Whirlwinds · Light · Compact · Powerful



Aircraft Engines

You Can Be a Mindreader

(Continued from page 71)

envelopes and seal it." However, "to show how this is done," he drops the card in the envelope and seals it *himself*. He does this quickly with several spectators, usually in different parts of his audience. He then throws out the remaining envelopes, scattering them from aisle to aisle, saying, "Now that you know how to put the question card in the envelope, I want you all to do it."

This seems to be the fairest kind of a proposition—but the faces of the envelopes which the performer has used to "demonstrate" how to insert the card have been cut away so that the envelopes actually have no fronts! A daring trick, yet it is used today by some of our really big-time mindreaders. Look at the illustration, make some envelopes of this type yourself, and you, too, can be a mindreader—if you have a glib tongue.

In the early part of this article, reference was made to "letters taking shape in the smoke." The use of one of these open-face envelopes (see illustration on page 71) and the proper theatrical setting, even in a home, give you the secret.

In connection with this particular stunt, let me call special attention to the fact that eight or ten questions are all that a performer has time to answer in a 15-minute performance. Inasmuch as he has "demonstrated" how to put the cards in the envelopes in various parts of the house, thus assuring answers all over the audience, and has then thrown out envelopes (perfectly good ones, which the audience is free to examine), people forget in the excitement that the performer has answered only a few questions—and, of course, they do not know that the only questions answered were those placed in the envelopes by the mindreader himself!

If time permits, the performer can gather up many of the questions which were placed in the good envelopes by members of the audience themselves, and sealed by them. He still can answer the questions! How?

Well, that brings us to the oldest method of "mindreading"—and the most effective. This is known as the "one-ahead" method. For sheer gall and brazenness, it is without equal.

Either using the method of the cut-out envelope, or having a "fake" message planted at the bottom of the stack of envelopes, the mindreader brings one of the truly sealed envelopes to his head. He answers some question already known to him. He now tears open the unprepared

envelope and openly reads the question written there while pretending to "verify" the previous question. He then merely repeats the question he had already answered while continuing to look at the card with the as yet unanswered question and asks "Is this your question?" By this method of "verification," the performer is always reading one question ahead. When he comes to the last envelope, all he has to do is to "verify" the last answer.

Another means of reading concealed messages is the "alcohol method" of making paper transparent (P.S.M., Nov. '44, p. 67). The trick consists simply of taking envelopes in which written messages have been sealed and then unobtrusively spraying them with alcohol to make them sufficiently transparent for the enclosed messages to be read.

A method in use some years ago, which was known as the Anna Eva Fay method, has recently come back into great favor with night-club mindreaders. It was named after one of the famous Fay sisters who popularized mindreading and used it for entertainment purposes only. It revolves around the use of what the profession calls "wax pads." Let me explain the act of one mindreader who today is drawing a very big salary, using this 40-year-old method. She appears on the floor of a night club after a very thrilling introduction by a gray-haired gentleman with a waxed goatee.

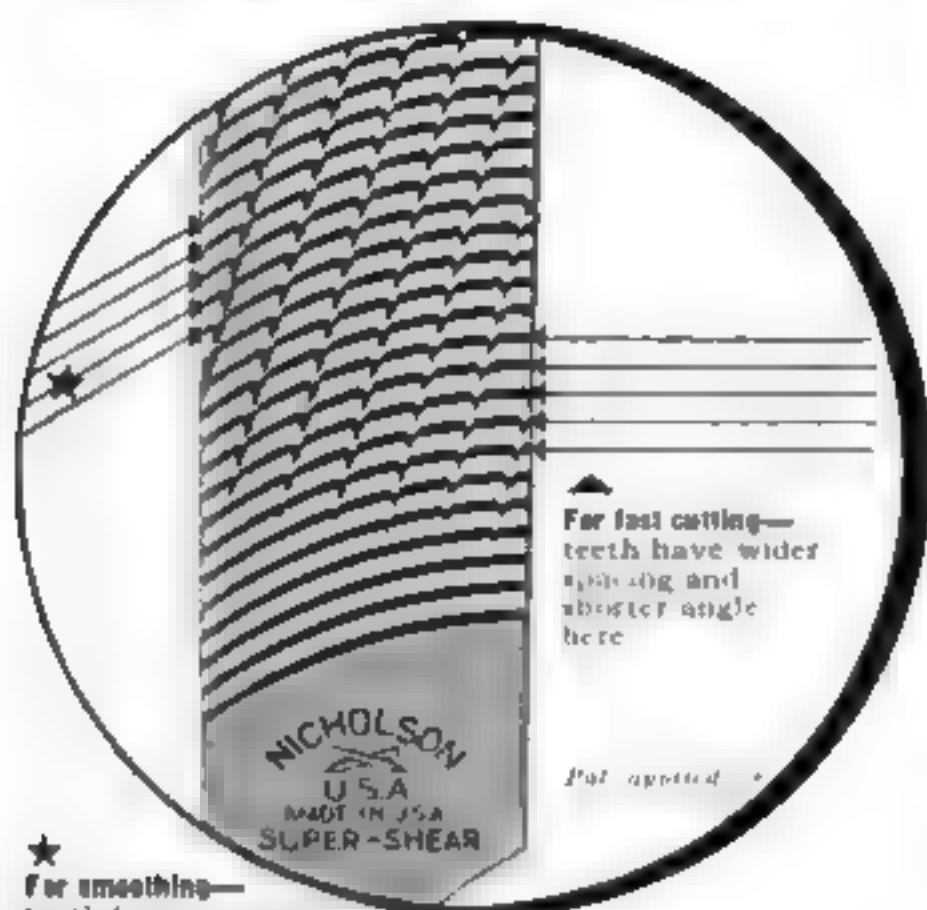
Dozens of pads are passed out to various tables by waiters. Questions are naturally written on the first sheet of each pad. The spectators are then instructed to tear off these sheets, fold them, and hold onto them. The waiters then gather up the pads and return them to the goateed gentleman, who is, of course, the performer's assistant. He carelessly throws them in a basket and innocently carries them off stage. Now "Madame Seer" tells the audience about mindreading, its possibilities, and how "only last week" one of the "big bankers of the city" solved a problem by getting her "psychic aid."

By this time, the lady's assistant has returned with a crystal ball and a large pedestal. Instantly, Madame Seer peers into the crystal glass and starts giving the initials of members of the audience and answering their written questions.

The pads on which the questions were written had no carbon paper, but still they were not completely innocent. Only the

(Continued on page 214)

IT Smooths AS IT ROUGHS



★ For smoothing—teeth have narrower spacing and longer angle here.

SUPER-SHEAR is the distinctively new Nicholson "double-purpose" milled tooth file for a wide range of uses: on the flat and convex surfaces of brass, aluminum, babbitt, bronze, copper, magnesium, cast-iron and soft-metal alloys; on plastics, hard rubber and hardwood.

The Nicholson Super-Shear is evidence that despite many long-established standards, there is constantly something new in Nicholson file designs. Note carefully . . . the curved teeth of this file are cut in an arc that is "off center" in relation to the axis of the file. Thus, the Super-Shear is virtually two files in one (see illustration)—providing fast cutting and smooth finishing in one operation. Easy to control for accurate work. Easy clearance that saves time and keeps file efficient when working on soft metals that clog ordinary files. Long-lasting quality and unwavering uniformity.

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FILES FOR EVERY PURPOSE
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You Can Be a Mindreader

(Continued from page 213)

first sheet of the pad was used, the waiters not giving those in the audience a chance to write on more than one piece of paper. The waiters were there to see that the pads were quickly picked up and brought back. The Anna Eva Fay method is a cinch under the dim lighting conditions of a night club. What is it? The photographs and captions on pages 68-69 gives you the answer.

The "Coin Test" is a home or living-room stunt, though it has been used in night clubs and on stages. The effect is this:

The performer takes a large envelope and asks for a cent, a nickel, a dime, a quarter, and a dollar bill. These are dropped in the envelope. The performer then calls off the date on each coin and the number on the dollar bill. The test is very impressive, the secret not so remarkable.

Preparatory to starting the trick, the performer built a second compartment in the envelope in which he placed a duplicate set of coins and another dollar bill. He memorized the dates on these coins and the number on the bill. The concealed coins are prevented from making a noise by the performer's holding the envelope tightly by one corner, and then dropping in all of the coins collected at one time.

Another good stunt with money is to memorize the numbers on a dollar or five-dollar bill. Keep this bill in your right-hand trousers pocket, fold it in four parts, in quarters. Then ask anyone in the group to take a one- or five-dollar bill from his pocket, fold it in quarters and hand it to you. As you receive the bill, because no one knows what you are going to do, you can switch the bill given you with the one that you have palmed—and the number of which you know.

Then pretend that you forgot to say that you did not want to touch the bill, so hand the bill back to the one who gave it to you. He thinks he is getting back the bill he originally gave you. Actually, he is getting back the bill the number of which you know.

Now ask him to hold the bill against his forehead. Say that through "psychic impulses" you will read the number of the bill which is in his hand. Few people will remember that you even touched the bill.

Subscribers in the armed services who notify us of change of address are requested to give us the key symbols appearing on the wrapper in which the magazine is received.

General Electric answers your questions about

JET PROPULSION

Q: Is it like a rocket?

A: No. A rocket carries fuel, but also the oxygen needed to burn it. A jet-propelled plane carries fuel for its G-E engine, but takes oxygen from the air as it travels through it. Thus, a rocket might travel to the moon, but a jet-propelled plane could never go beyond the earth's atmosphere.

Q: Is it like the German robot bomb?

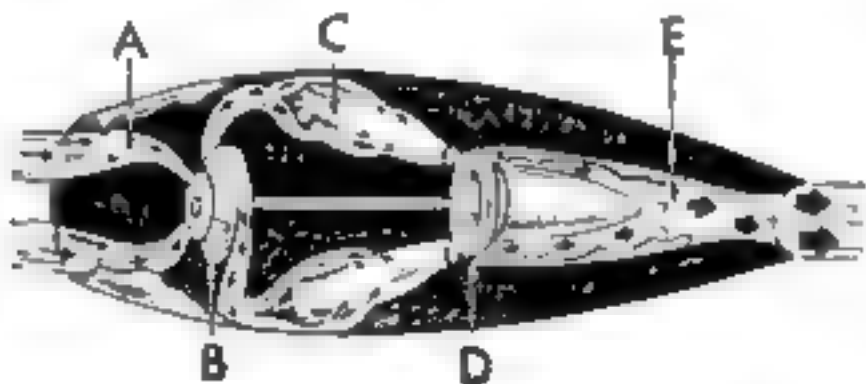
A: A little. The robot bomb uses a crude form of jet propulsion. But it hardly compares with a power plant that can drive fast, high flying jet-propelled fighter planes. Pilots find these new planes easy to handle.

Q: What was G. E.'s part?

A: General Electric engineers developed the jet propulsion engine from an original design by Group Captain Frank Whittle of the R. A. F. General Electric was chosen by the Army Air Forces because of G. E.'s long experience with steam turbines and turbo-superchargers.

Q: What makes the jet plane go?

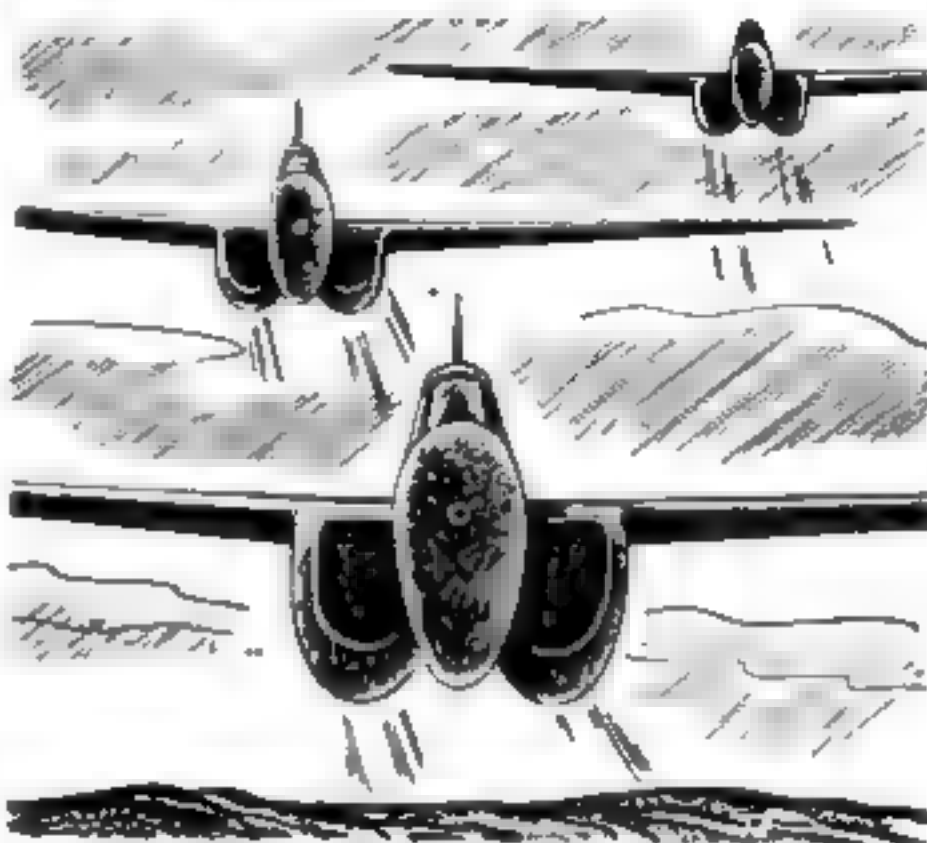
A: The same kind of force that makes a toy balloon scurry when it slips from your fingers or that makes a gun kick against your shoulder or that makes a rotary lawn sprinkler turn. In fact, you probably see forms of jet propulsion every day.



Q: How does the engine work?

A: Air flows from "A" through compressor

"B" into combustion chamber "C," where it is heated and expanded by burning fuel. Rushing toward the outlet, part of this hot gas turns turbine "D," which operates compressor "B." From here gas rushes through nozzle "E." The jet from this nozzle drives the plane forward.



Q: What does the jet plane look like?

A: At first glance it looks much like any other plane. But a closer look will show you that the propellers are missing and that there is no sign of conventional engines. Here is a sketch showing the P-59A, built for the Army Air Forces by Bell Aircraft. This plane is powered by two General Electric jet propulsion engines.

• • •

The General Electric jet propulsion engine is one of hundreds of products made by G. E. for the aviation industry. G-E science and engineering work to supply America's needs—in war and peace. General Electric Company, Schenectady, N. Y.

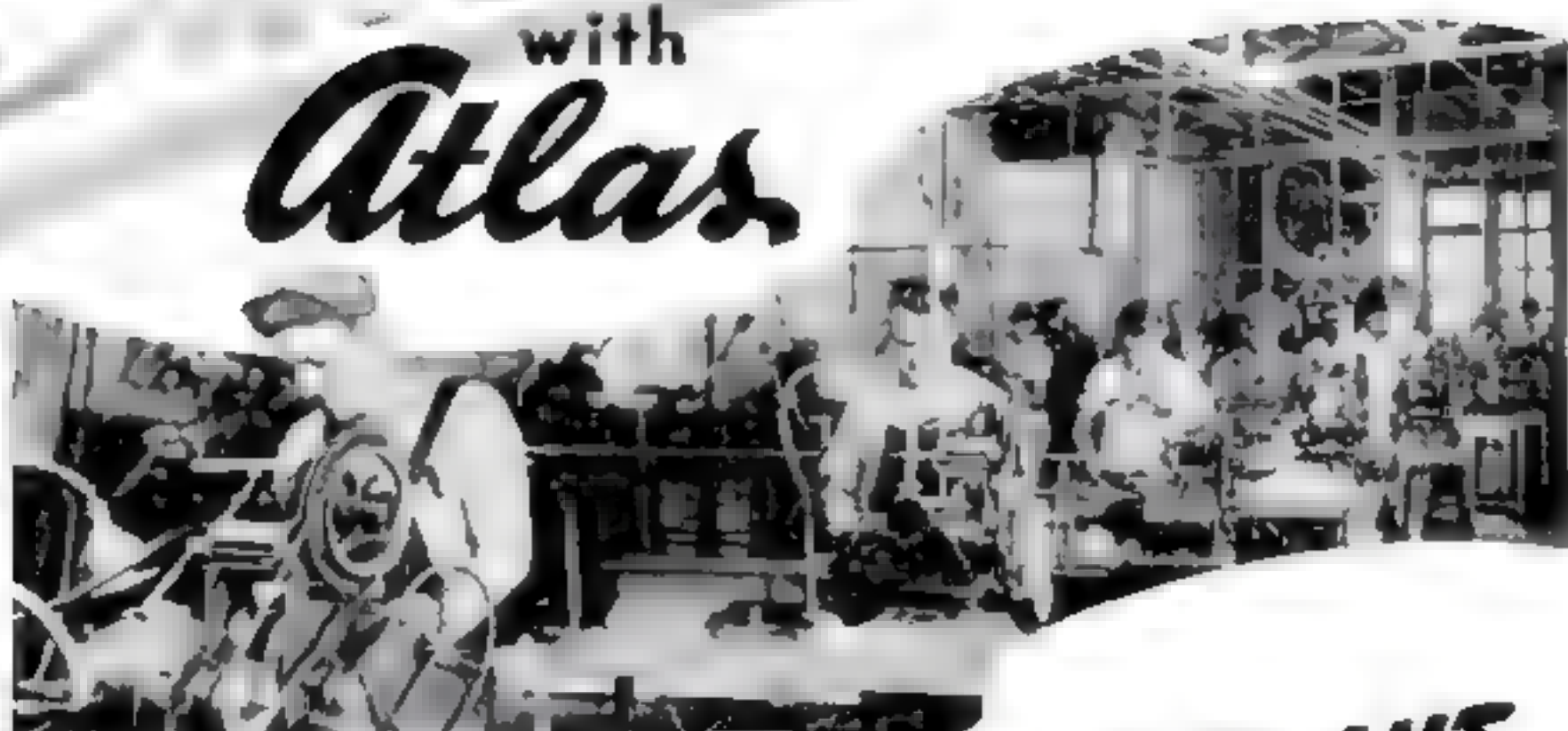
GENERAL  ELECTRIC

DDZ-216-211

Hear the General Electric radio programs: "The G-E All-Girl Orchestra" Sunday 10 p.m. EWT, NBC—"The World Today" news, every weekday 6:45 p.m. EWT, CBS.

FOR VICTORY—BUY AND HOLD WAR BONDS

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Atlas



BUSY PLANT STARTED WITH TWO MACHINES



From a small maintenance shop with one Atlas lathe and one Atlas drill press to the layout shown here is the remarkable success story of the Sam Mulkey Company, Kansas City, Mo.

Mr. Mulkey wanted to do his part in war production and asked several war contractors for work on precision parts for his two machines. He did a good job. They wanted him to do more. From a 10' x 18' shop he now finds a 50' x 135' building too small.

Today in his shop there are 34 Atlas lathes, 20 Atlas drill presses, 7 Atlas milling machines, and 4 Atlas shapers plus a number of specially built machines made entirely in the shop on Atlas equipment.

Sam Mulkey's success story is typical of hundreds founded on Atlas tools—and encouraging to men who plan to build businesses of their own tomorrow. If you are thinking of machine tools for your home or commercial shop after the war, send for the latest Atlas catalog now.



NEW ATLAS PATTERN SERVICE

Using the template principle so valuable in war plane construction, Atlas now supplies time-saving patterns for wood craftsmen. Look up the ad on page 266

ATLAS PRESS CO.

1255 N. PITCHER STREET
KALAMAZOO 13D, MICHIGAN

LIGHTER MOMENTS with **fresh Eveready Batteries**

DATED



**"She suggested keeping me company while
I'm walking guard duty, Sarge!"**

**"Keep your eye on the infantry—the dough-
boy does it!" The more you spend for War
Bonds the less it will cost for Victory.**

OUR ARMED FORCES all over the globe and the essential industries supplying them require nearly all the present production of "Eveready" flashlight batteries. Naturally there is a scarcity of these dependable batteries right now for civilian needs.

After the war, however, you will be able to get new and improved "Eveready" batteries—engineered for even longer service, more efficiency.



The word "Eveready" is a registered trade-mark of National Carbon Company, Inc.

WRITE A SLOGAN...

WIN



WHAT KIND OF A "LIGHT" DO YOU WANT IN YOUR HOME AFTER THE WAR? SEE THIS NEW LIGHT AT YOUR DEALER'S

● VERD-A-RAY is a new type of incandescent light bulb scientifically designed to make seeing easier. In comparison with the "pinkish" white light of ordinary frosted lamps, note the comforting "pastel greenish" white light emitted by VERD-A-RAY.



VERD-A-RAY



ORDINARY BULB

Scientific research data indicates improved visual (sharpness) acuity, relief from eyestrain and reduced glare.

Many war plants use VERD-A-RAY; one such plant reporting in a trade paper that hospital treated headaches were reduced 69.13%, hospital treated minor accidents were reduced 54%, and 357 productive manhours were saved in one department in one month after proper installation of this new "glareless" lamp.

Nothing to buy. Your dealer has entry form and rules of contest. If not, write direct. Any combination of six words or less, descriptive of VERD-A-RAY may win a prize.



It's a Rugged Gun

(Continued from page 83)

the 142nd Infantry was dug in on Mt. Artemisio, just beyond Velletri. It had moved up there, along with the rest of the regiment, by a forced march at night, and occupied the heights virtually without opposition. Its mission was to drive south and east and cut Highway 7, the road to Rome, between Velletri and Genzano.

Dawn was just breaking as a reconnaissance patrol moved out to make contact with the enemy and probe his line for a weak spot for a break-through. There were 12 men on that patrol, led by a second lieutenant. There were eight riflemen armed with Garands, two BAR boys and their assistants. These men all moved down the heavily wooded slope in a rough V formation, the two wings branching out right and left with the BAR boys in the rear, commanding a clear field of fire forward.

Naturally, everybody walked softly. Communication was by arm and hand signals, relayed up and down the line. Ahead lay a small hillock, densely wooded, with undergrowth filling in the ground between slim, tall trees. At a signal from the lieutenant, the patrol started to deploy, with one file by-passing that mound on the left and the other on the right. Suddenly the silence was ripped wide open by the "b-r-r-r-up" of a Kraut machine gun—maybe a Spandau, a gun that shoots at the rate of possibly 1,500 rounds a minute.

Our doughfeet dropped to cover and opened up. The BAR boys covered the crawling advance of the riflemen by continual quick bursts of twos and threes and fours until their GI pals could get right in there to the enemy and use their hand grenades. Then on to another objective.

That is about the way the BAR would be used by attacking infantry. If Jerry was launching a counterattack, the BAR boys would be dispersed among groups of infantrymen controlling overlapping sectors of fire.

Like other automatic weapons, the BAR is most effective when fired in short bursts. Even an expert cannot hold steady on a target when more than four or five shots are released at one pull of the trigger. Long bursts are used only for surprise or where a long target—a column of men, for example—is taken in enfilade.

Every BAR team is specially trained, so that each man can disassemble the weapon blindfolded and make minor adjustments and repairs. A special pouch, carried by the assistant rifleman, contains tools and spare parts likely to be needed in action.

With a TR on his shoulder

... AND THE KNOW-HOW UNDER HIS HAT

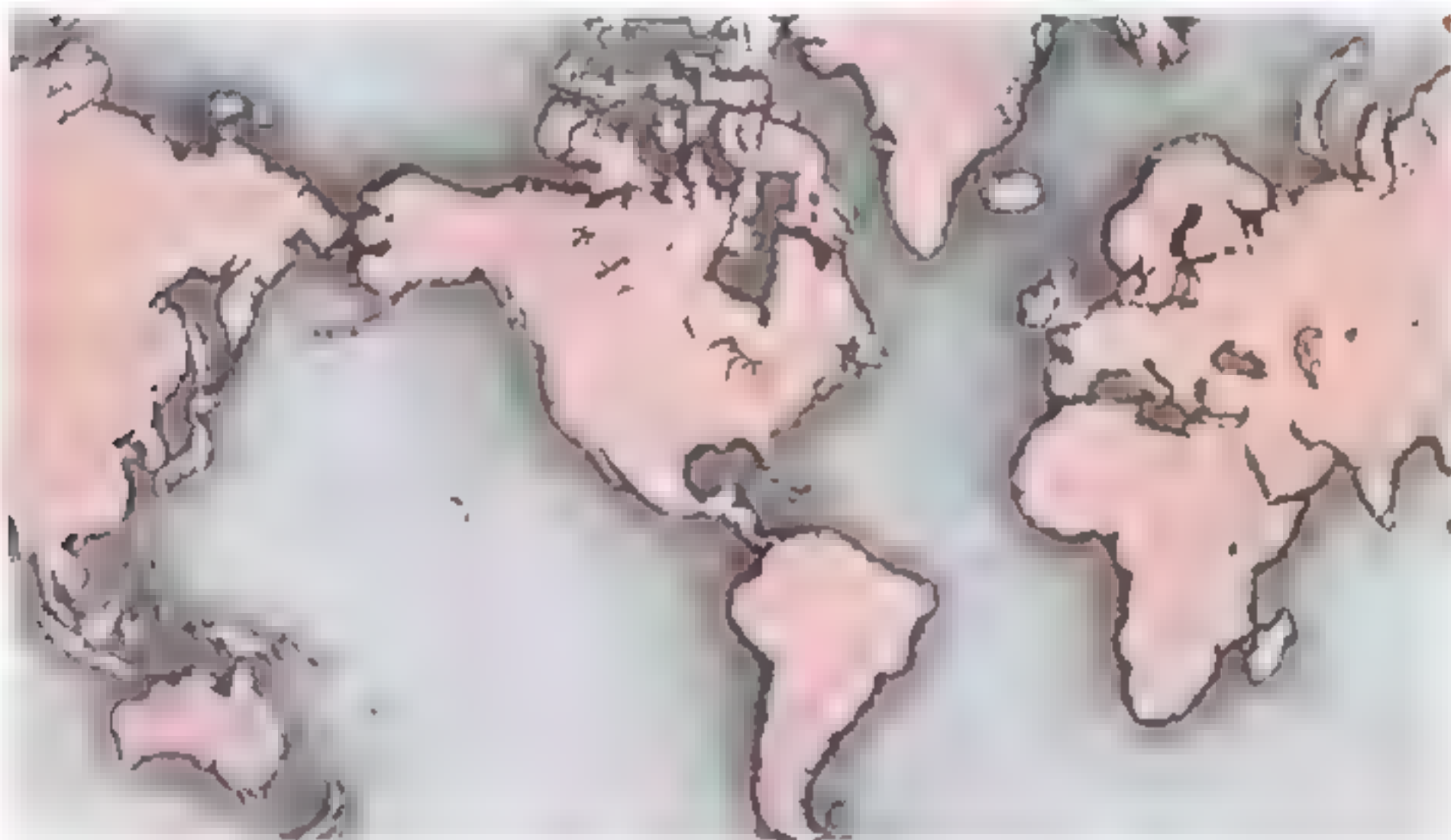
YOU'LL find him in every corner of the world where American weapons of war are in action...

He's in uniform, but he's a civilian. And his shoulder patch reads "Tech Rep."... *Technical Representative.*

TR's not only help to see that our complex weapons perform reliably under combat conditions—they help our soldiers, airmen, sailors, and seamen to

understand the new devices constantly reaching the fighting fronts... new planes... improved gun sights... intricate flight instruments... ship navigating instruments.

And, in the course of his duties, the TR sometimes stops hot lead... or becomes a prisoner of war. For his duties often mean sweating it out in a foxhole, or riding in a bomber on an actual mission.



Wherever our Armed Forces go—there's a Sperry TR

The nearly 600 Sperry TR's, and their associate Field Engineers in this country, receive highly specialized schooling and months of experience.

For, once on their own in some remote spot, they must be able to keep the gyros spinning in airplanes... repair a shot-up computing sight... adjust a revolving gun turret... overhaul a ship's Gyro-Compass... repair a hydraulic ammunition hoist.

One American General recently said that not only have Sperry TR's trained thousands of Servicemen in the proper maintenance of equipment made by Sperry, but, "through observation of combat performance, have been instrumental in indicating improved methods of manufacture and maintenance." Many TR's, he added, have performed this essential service at great personal risk to themselves.

SPERRY

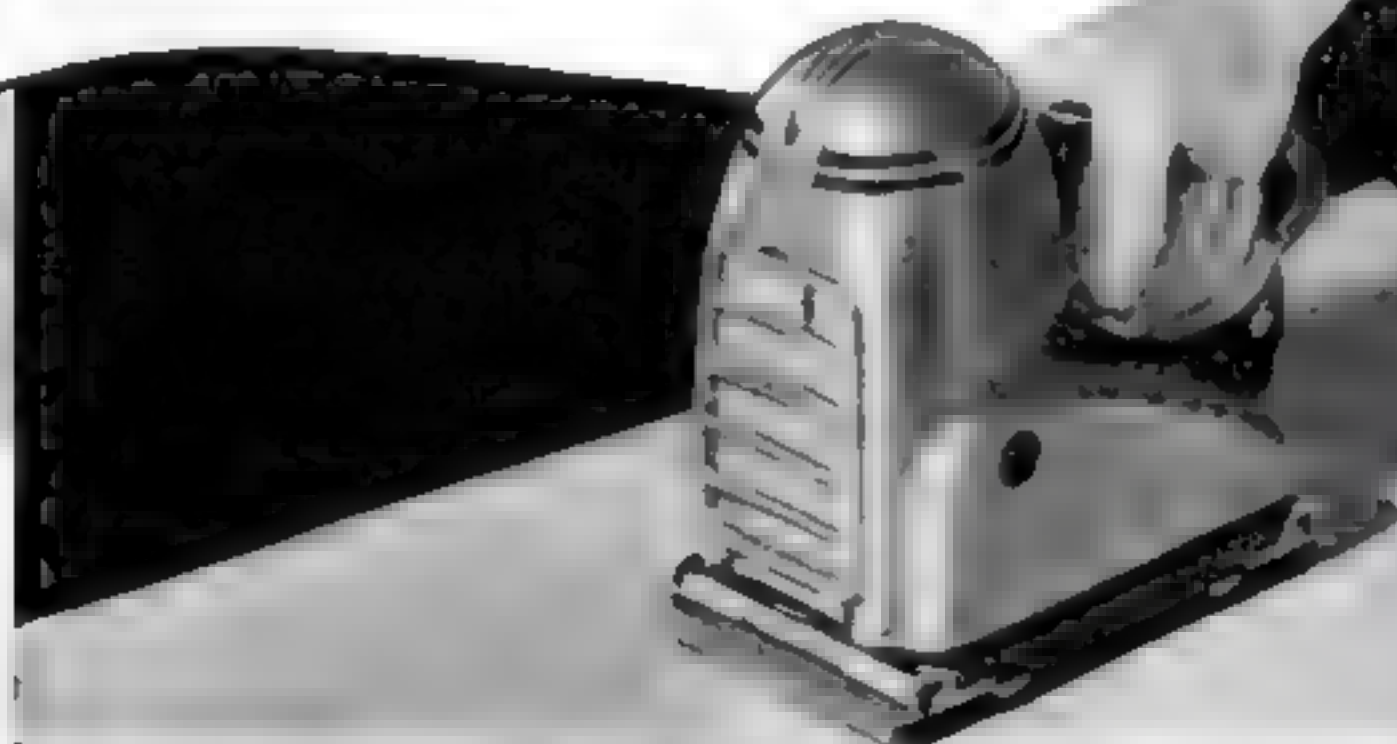
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Through the following Divisions, our TR's help to see that Sperry precision instruments and controls serve the Armed Forces on land, at sea, and in the air.

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Ingenious New Technical Methods

Presented in the hope that they will
prove interesting and useful to you.



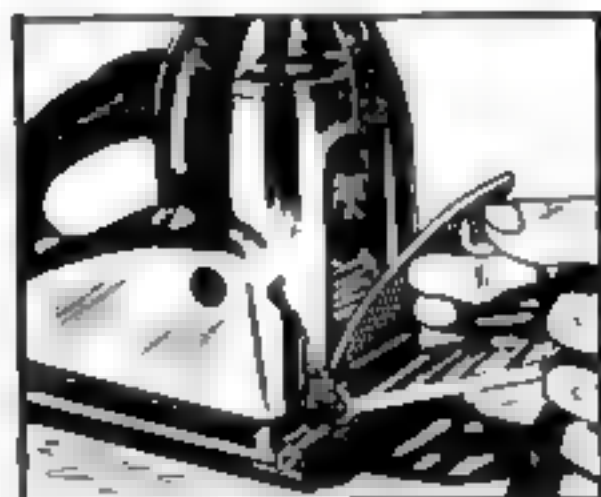
No Vibration in New "Orbital Action" Portable Electric Sander; Relieves Workers' Fatigue

A boon to workers' nerves and health, this new "Orbital Motion" electric sander is actually vibrationless. A great saver of workers' energy as well as man-production hours, the sander can be operated easily in horizontal, vertical or inverted position with one hand. Compared to manual sanding, this machine achieves superior results at least eight times faster. It performs equally well on wood, metal or plastics.

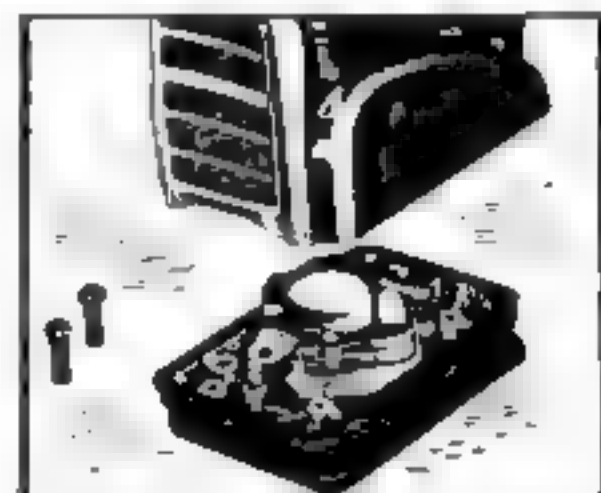
Developed for war industry, this revolutionary new sander has done yeoman duty in this country's manufacturing plants and in allied maintenance and repair depots all over the world.

Wrigley's Spearmint Gum renders a real service to workers too—eases dry throat and relieves tension that brings on fatigue, leaving both hands free to stay on the job. The Army and Navy were quick to appreciate these benefits, that's why they are now shipping to our fighting forces overseas only, our entire limited production of Wrigley's Spearmint. Just as soon as we can supply the home front, too, industry will again enjoy the benefits of Wrigley's Spearmint Gum now proving so important on the battle fronts.

You can get complete information from Sterling Tool Products Company, 155 East Ohio Street, Chicago 11, Illinois



Easily-removed filter cleans air that cools motor—prolongs motor life and reduces maintenance costs.




Dustproof transmission synchronized to eliminate vibration. Oil supply lubricates for 100 operating hours.

Y-163



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 The life of an engine depends largely on the care it gets. This life can be shortened by neglect, or greatly extended by proper attention.

Today millions of engines are operating efficiently, long beyond their normal span . . . because they have been watched closely, checked frequently . . . and serviced at the first indication

of trouble. Every engine is a trust in its owner's hands. Take no chances . . . protect your vital transportation . . . replace worn parts before undue wear occurs! Consult your motor specialist regularly and often.

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HASTINGS STEEL-VENT PISTON RINGS

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● Keen teeth that bite crisply into material... that leave smooth edges... that hold an edge with remarkably little filing... these are the kind that make woodworking a real pleasure. Whether you use saws for pleasure or profit, get the advantages that Atkins "Silver Steel" Saws assure: fast cutting, clean work and long life. Keep checking with your hardware dealer. If he doesn't have the exact Atkins Saw you want, it shouldn't be long before he again has a complete stock.

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BEST BUY
IN SAWS

Silver steel
by **ATKINS**

Meet the Invader

(Continued from page 81)

of several potent combinations of bombs, machine guns, and cannon.

When the A-26 is "compromised"—the Army way of saying the enemy has captured a new plane and is studying its vitals—our foe will view some surprising developments in the field of attack bombardment.

He will inspect, for example, the all-purpose nose, an unusual arrangement which permits the Invader to be fitted while yet on the production line with special equipment for special missions. In the nose may be mounted light machine guns for strafing or heavy cannon for blasting important installations, on the sea and ashore.

A new canopy gives the pilot better vision, especially important during tight formation flying, when large numbers of Invaders operate against enemy fighters.

The enemy will note the two full-feathering, three-blade propellers, both turning clockwise, made by Remington Rand and Nash Kelvinator under license from Hamilton-Standard. He will grudgingly admire the R-2800 2,000-hp. engines, built by Ford under license from Pratt & Whitney.

He may guess at the four-part exhaust stacks pointed backward through the cowls. These neat little gadgets, thanks to the ingenuity of Douglas engineers, act something like jets, and, by recovering the energy ordinarily wasted in the exhaust manifolds and forcing the gases backward, serve to increase the engines' output by several hundred horsepower.

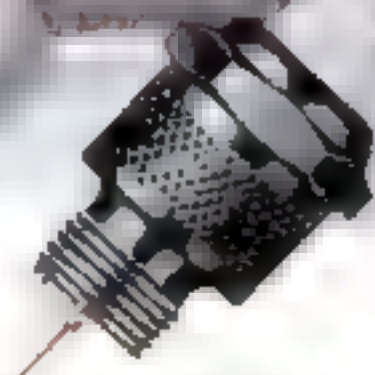
Our enemy will find, too, that the Invader is considerably larger than the A-20. In fact, its weight actually puts the Invader in the class of a medium bomber such as the B-25 Mitchell. The enemy already is learning that the A-26 cruises around 300 m.p.h., and can maintain surprisingly high altitude even when limping home on one engine.

Specifications for the A-26 were perfected by the AAF Materiel Command at Wright Field, Ohio, in 1940. Douglas engineers designed the plane, and on July 10, 1942, Benny Howard, company test pilot, lifted the first XA-26 from the ground. Another two years of testing and improving followed, during which hundreds have been completed and flown away to combat.

The Invader was the first Douglas plane designed for mass production. It contains several innovations, at once novel and effective in improving the attack bomber's performance. Chief among them are the combination of a new NACA low-drag laminar-

(Continued on page 226)

INSIGNE OF ARMY ORDNANCE



WHERE DEPENDABLE IGNITION MEANS DEPENDABLE PERFORMANCE



Weasel with its troops

... YOU'LL FIND DEPENDABLE CHAMPION SPARK PLUGS

The "Weasel," built by Studebaker, is one more of those startling developments which have characterized American inventiveness throughout the war. Specially designed, in cooperation with Army Ordnance engineers, as a cargo and personnel carrier with the ability to negotiate terrain and surfaces impassable to other wheeled or tracked vehicles, it has already proved itself unequalled at such tasks in several theaters of war. Here, as in so

many of the highly specialized vehicles of war—tanks, trucks, jeeps, half-tracks, ducks and alligators—the essence of good performance is dependability. To have dependable performance, you must have dependable ignition. This is where dependable CHAMPION SPARK PLUGS play their vital part—why Champions are used in the "Weasel" as in engines of every size and type in the service of our armed forces on land, water and in the air.

Buy an EXTRA



\$100 War Bond



TO SAVE
GASOLINE
—KEEP SPARK
PLUGS CLEAN

CHAMPION SPARK PLUG COMPANY, TOLEDO 1, OHIO

DECEMBER, 1944

Buy War Savings Bonds and Stamps regularly.

223



It helped us take the beachheads in Normandy!

Where but in America could you see a sight like this?...

Cars by the thousands on the roads . . . new, sleek, powerful machines driven, not alone by bankers and millionaires . . . but by 30 million average Americans.

It was the wonder of the world . . . and you made it possible.

For you had a restless, burning ambition for better and still better things . . . you forced American industry to fight for your favor . . . by improving, expanding, searching for new ways to give

them to you and to your family.

That is "The American Way."

It inspired Chrysler engineers, for example, to invent improvements for your peace time cars that helped our fighting men take beachheads in all parts of the world, press on to Victory on land, sea and in the air.

It gave us, and the rest of free American industry, the will and heart to grow big, strong . . . until we were ready to out-produce the regimented Axis nations at their own game of war.

You were the driving power . . . you were the driver. And, because this is "The American Way," you will start again asking us to give you even better cars than before.

And you will get them!

CHRYSLER

DIVISION OF CHRYSLER CORPORATION

Buy more War Bonds than ever before

PICTURE OF A DREAM

about to be



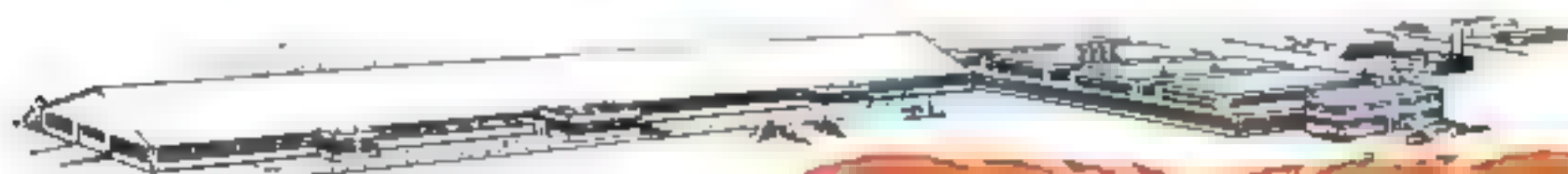
TOMORROW'S FAMILY AIRPLANE! WHAT WILL IT BE?

- Low-wing? High-wing? All-wing?
- Will it be metal? or plastic? or what?
- Will it have one engine? or two?
- How about speed?
- Will it be even simpler to operate than a car?
- What will it cost?

These intensely practical considerations today are guiding Taylorcraft engineers as they design and re-design the fundamental improvements of the light plane for war which will become the family airplane of the future—the

airplane that you, your family and your friends will fly.

Since 1941, the only aircraft Taylorcraft has produced have been planes for war—"grass-hoppers" that fly at low altitudes, spotting troop movements, carrying messages, taking off from and landing in rough, postage-stamp fields. But Taylorcraft hasn't forgotten its obligation to the American people as its past and future customers, to perfect the safe, sure, low-cost airplane of advanced design that will fully measure up to tomorrow's needs. That obligation is being met.



Taylorcraft

World's Largest Builders of Side-by-Side Airplanes

TAYLORCRAFT AVIATION CORPORATION • ALLIANCE, OHIO

WORKSHOP WISDOM

How to mend crockery

ALTHOUGH Cascamite Plastic Adhesive is a wood glue, you can use it to make cold-water-proof repairs on thick, porous crockery. Here's how:



1. Make a heavy mixture of Cascamite powder and cold water. See directions on container.

2. Apply glue to broken edges and let stand a minute or two until glue starts to get tacky.

3. Press adjoining edges together tightly and apply pressure with rubber bands or clamps if possible. Let dry 8 hours or more.

Get these three wood-gluing advantages with Cascamite:

Waterproof. Ideal for joints to be exposed to weather, water, or continued dampness.

Stronger. By actual test, joints made with Cascamite are as strong as the wood itself.

Stainfree. Cascamite can be extended with ordinary household flour to make a low-cost, water-resistant glue that will not stain or discolor light wood or thin veneers.

You can get Cascamite Plastic Adhesive—and Casco, the all-purpose household glue—in 10c, 25¢, and larger sizes at all hardware stores.

Send for free Gluing Guide containing helpful gluing hints, also free Casco Project Booklets. Drop a post card today to

CASCAMITE

Plastic Adhesive

350 Madison Ave., Dept. S-3, New York 17, N. Y.



Meet the Invader

(Continued from page 222)

flow airfoil section and a new Douglas-designed slotted-type wing flap, the wing itself being a new type of structure.

The wing is described as of two-spar cantilever construction, and is composed of left-hand and right-hand panels, in which the engine nacelles are integral parts. Spars are "built up" from long, unspliced spar caps carrying integral end fittings.

The slotted flaps, installed on the trailing edge of the wing, provide both high lift and adequate drag, enabling the Invader to make short take-offs and landings. This means that the plane can operate from rugged, tree-fringed advance bases near the fighting fronts, all over the world.

Unlike many other plane types, the semi-monocoque fuselage resembles a long box, being practically square with rounded corners in cross section. Tunnels penetrate each side for carrying electric, hydraulic, heat and vent, and instrument lines to facilitate service and repair.

Every effort was made to provide a "field airplane," meaning one that mechanics on distant fronts can service quickly and readily. The accessible and quick-change engine installation is one important feature. A complete engine change may be made in about one hour, with no need to worry whether a starboard engine is being installed on the port side. Mechanics can sit in the nacelle and work on the engine comfortably.

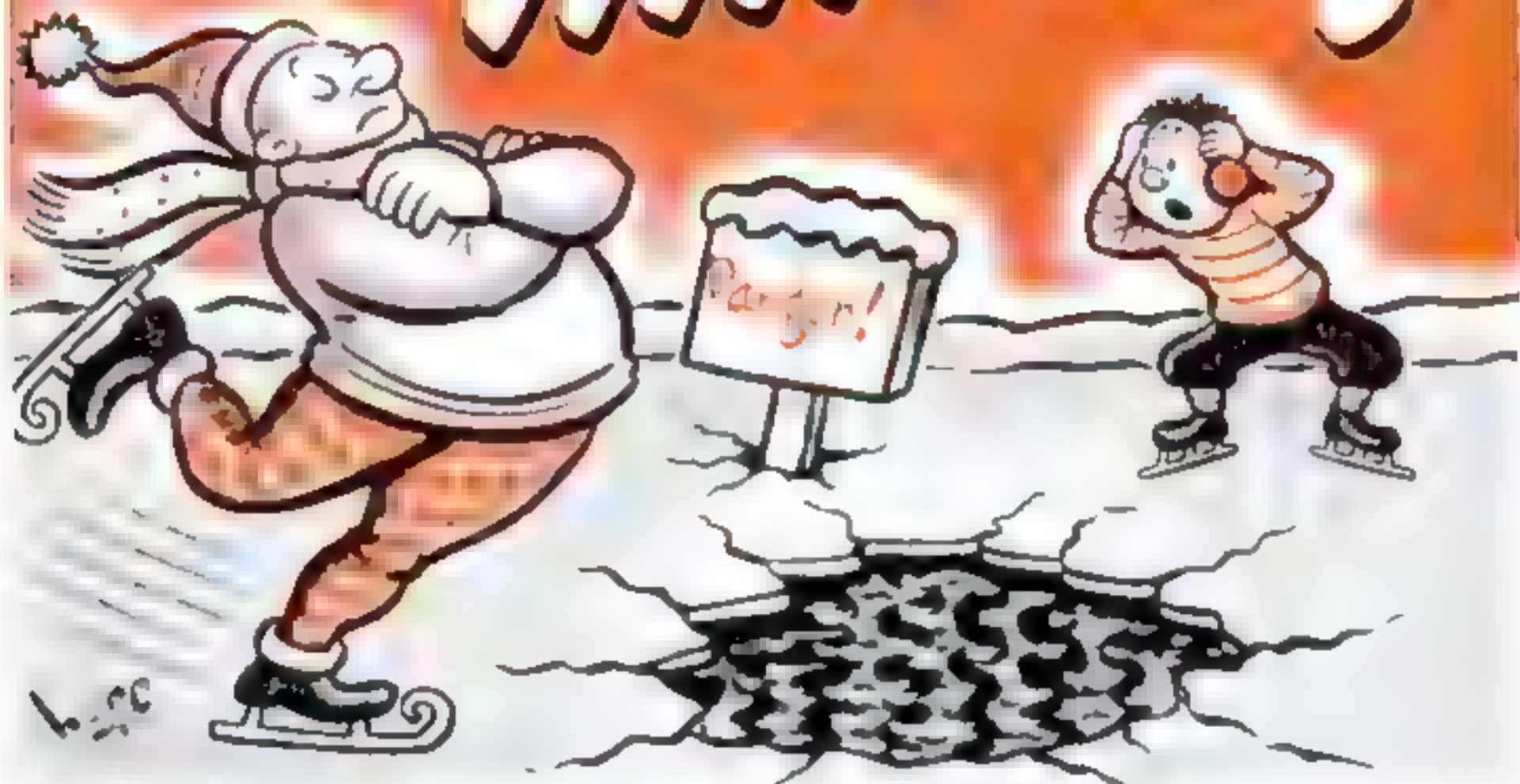
Sheet metal replaces welded tubing in the mount, too, by using a large metal spinning in the forward part and stainless steel in the after part, tied together by six identical forgings extending from the engine to the nacelle. Again, this arrangement eliminates a large volume of welding on the production line and gives mechanics plenty of room to work on the installation after entering through an access door in the firewall.

Three experimental models were produced around the basic design. First was the XA-26, a light bombardment attack version; next was the XA-26A night fighter, which took wing in January, 1943; third was the XA-26B, mounting a large-caliber cannon for destroyer work. Success of these three led to production of the A-26B, in which heavy armor plate was added for the pilot.

Now, drawing upon combat experience, a new and deadlier Invader is being readied. It is to carry the same armament, but this destroyer will fly even faster, to surprise more of the enemy with its unexpected intrusions and quick getaways. —ANDREW R. BOONE.

Don't let a Weak Battery
put you on

TWIN ICE!



Buy the Battery Experts Choose

Be guided by the experts who choose batteries for the world's toughest transportation services. For example, the million-mile trans-ocean flying record was established by a Pan-American Clipper equipped with Auto-Lite batteries.

Auto-Lites are specified,

too, for service with our fighting forces in tanks, half-tracks, jeeps . . . wherever dependable power counts.

Get the long life . . . the extra power you need. Buy an Auto-Lite battery—specified as original equipment by leading automotive engineers.

AUTO-LITE BATTERY CORPORATION
TOLEDO 1, OHIO

Manufacturing Plants at: Niagara Falls, Atlanta, Indianapolis, Detroit, Oklahoma City, Toronto



Tune in
AUTO-LITE'S

GREAT RADIO SHOW
STARRING
DICK HAYMES
IN
"Everything for the Boys"
Every Tuesday Night, NBC Network
Featuring stars of stage, screen and
radio and men and women of
the fighting fronts

AUTO-LITE BATTERIES

Auto-Lite means Auto-Life

FOR MEN WHO REALLY KNOW PIPES

Royalton

CROWN



TRANSPARENT MOUTHPIECE

MOUTHPIECE TUBE
prevents backflow of moisture

CONDENSING CHAMBER
traps and holds bitter juices and sediment

BOWL GUARD
keeps shank and bowl dry

UNBREAKABLE JOINT

CHAMBER GUARD
bars tobacco fragments from bit

Patented

Selected Briar

\$1.50

✓ THE PROOF OF THIS PIPE

IS IN THE SMOKING.

No need for glittering generalities or extravagant claims to describe the Royalton Crown. Men who really know pipes will recognize in those SIX PATENTED FEATURES the elements that make this the only pipe of its kind—a pipe that *stays overlastingly dry*. Condensing well drains out bitter fragments and juices—keeping bowl and mouthpiece, free of all impurities. Advanced construction assures efficient, speedy cleaning.

HENRY LEONARD & THOMAS, INC., OZONE PARK, N. Y.



"PARADISE" is at the CITY LIMITS for AERONCA Owners!

Imagine getting to your favorite resort in just a few hours after leaving your home! Imagine arriving there cool, clean, relaxed, refreshed! Imagine *flying your own Aeronca* to your vacation "Paradise" for less than it costs to drive your car!

Make no mistake—the new, post-War Aeronca is the plane *you* will want to fly and

own! It's so easy, that almost anyone who can drive a car can learn in a few hours. And anyone who can afford a medium-priced car can own an Aeronca!

Send for booklet showing details of the post-War versions of America's Personal Plane and telling you what opportunities await you as an Aeronca Dealer in your community!

Mail this Coupon!

AMERICA'S PERSONAL PLANE
AERONCA
AIRCRAFT CORPORATION
MIDDLETOWN, OHIO

Al Benson, Director of Sales
Aeronca Aircraft Corp.,
Middletown, Ohio

Please send me your valuable, illustrated booklet "Why You Should Be An Aeronca Dealer" I enclose 10c.

Name _____

Address _____

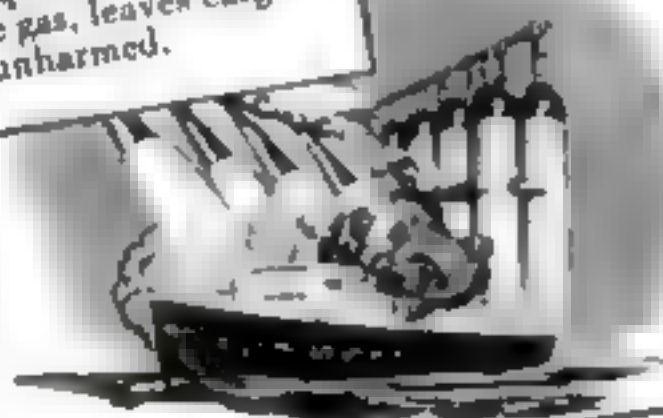
City _____ State _____ W-12



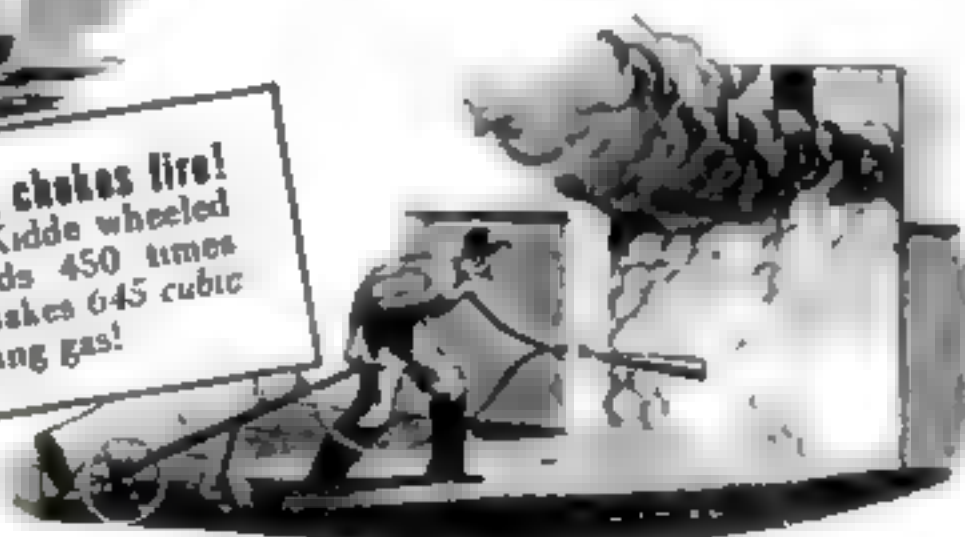
Raft inflates in mid-air!

Rolled up to save precious space, this rubber raft unfurls and quickly inflates itself in mid-air when dropped by patrol plane to rescue flyer downed at sea. Fast-acting buoyancy comes from carbon dioxide gas shot from small Kidde cylinder attached to raft.

Gas barrage controls fire afloat! On cargo ships, Kidde Extinguishing System kills fire quickly with gale of carbon dioxide gas, leaves cargo and machinery unharmed.

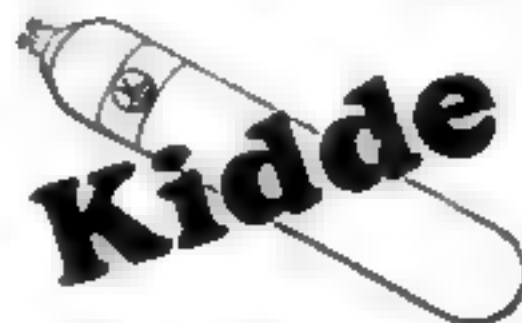


Cylinder fills room, chokes fire! Carbon dioxide in Kidde wheeled extinguisher expands 450 times when discharged, makes 645 cubic feet of fire-smothering gas!



Gases-under-pressure, harnessed by Walter Kidde & Company, are serving our fighting men in many ingenious ways. After the war they'll serve you. Look for them!

WALTER KIDDE & COMPANY, INC., 140 CEDAR ST., NEW YORK 6, N. Y.



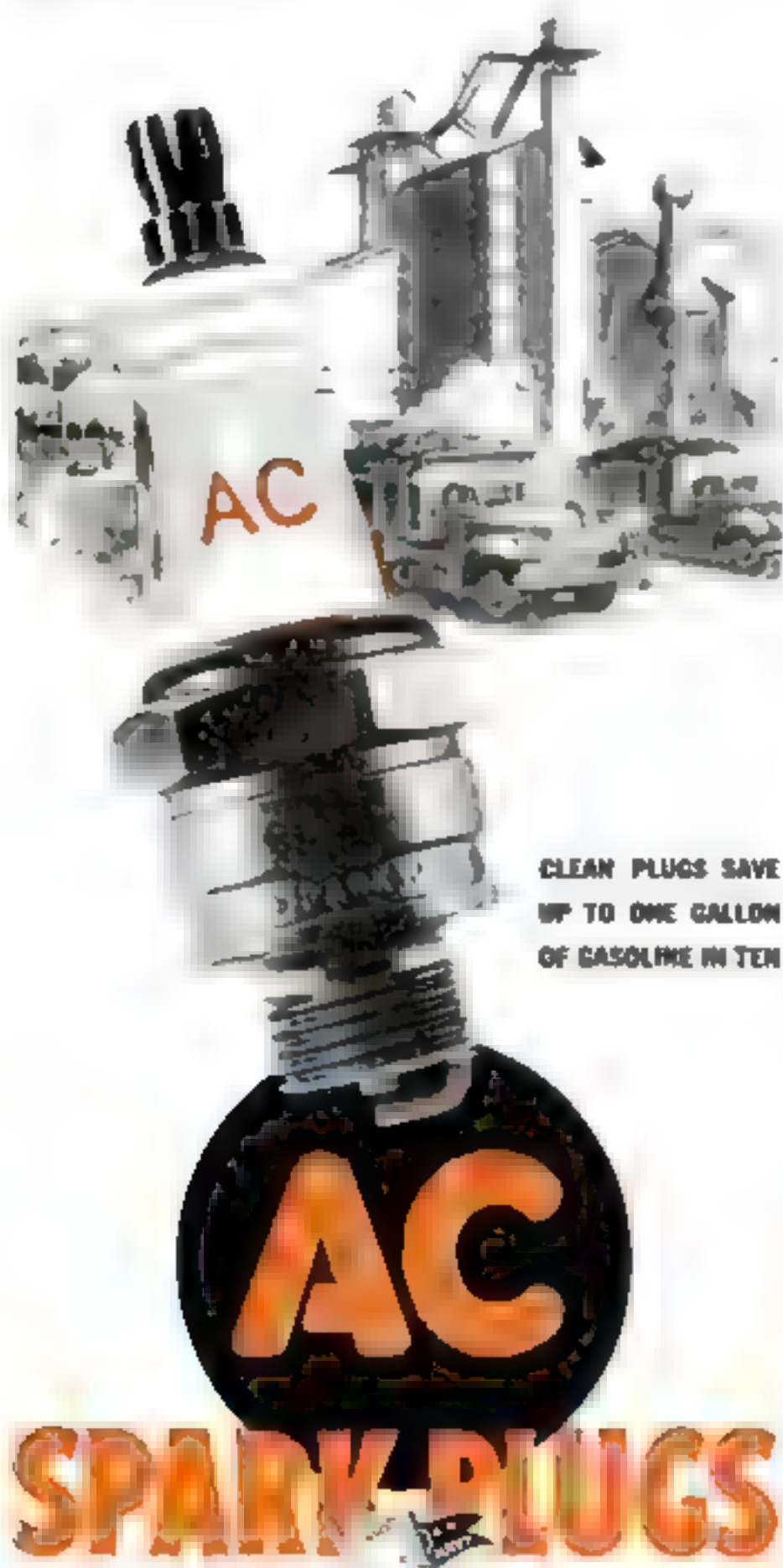


Grumman Hellcats—U. S. Navy Spearhead

Grumman

AIRCRAFT ENGINEERING CORPORATION, Bethpage, L. I., N. Y.

To keep the home fires burning—and factory wheels turning—and war goods moving by train and ship—tens of thousands of motor trucks are busy day and night, hauling vital coal. **AC Spark Plugs**, chosen for utmost reliability, play an important part in this work, keeping truck power up and fuel costs down. A convincing majority of truck owners save gasoline and lengthen spark plug life by having plugs cleaned and adjusted every 3000 miles. To save money for yourself and vital materials for the fighting forces, have your plugs cleaned regularly, and replace worn plugs promptly with new AC's.



BUY WAR BONDS AND BRING VICTORY QUICKER

America's Diamond Field

(Continued from page 72)

monds can be traced back to a source in Canada as fabulously rich as the Kimberley fields in South Africa.

Diamonds originate in rock of the peridotite class, a hardened mass of molten matter pressed into the carrot-shaped vents or pipes of long-extinct volcanoes. The mother lodes of the African diamonds are in such tubes in the earth's surface. As time passed, those volcanic cones eroded and their contents mingled with other soils. Streams fanning out from the sites of the cones strewn some of the diamonds along their beds. The diamonds were traced upstream to their places of origin by the early prospectors in Africa.

The hope of finding great diamond fields in Canada is based on the discovery of diamonds in the glacial debris brought southward 20,000 years ago by a mountain of ice. This huge continental glacier originated on the plateau east of James Bay, the southern arm of Hudson Bay, and crawled south into what is now New York, Ohio, Indiana, Illinois, Michigan, and Wisconsin.

As the glacier moved, it scooped up soil and rocks and froze them into its body. This hard material scoured and scratched the underlying rocks, leaving a record of the glacier's course comparable to the furrow left by a plow.

Points where the glacier paused are marked by sandhills and depressions known as "kettle moraines." Such hummocky land was built up by the action of the waters of the melting ice. Diamonds have been found in the deposits of glacial debris at such places, suggesting that at some point the glacier crossed diamond-bearing rock.

If, among 10,000 haystacks, a few needles were found by mere chance, it would be logical to suspect that there was a needle factory somewhere near by. Geologists have reasoned similarly regarding diamonds. They believe that some of the diamonds found in the United States came from somewhere in the far north, probably the Canadian wilderness below Hudson Bay.

Very little of the tremendous amount of material that was brought south by the glacier has been searched for diamonds. Some may still be hidden deep in the debris. Others may be exposed, but not noticed, for a diamond in the rough is not as brilliant as the stones you see in jewelers' windows.

Tracing glacier-borne diamonds to their point of origin will not be easy. Yet there are clues that, if followed with perseverance and patience, might lead to one of nature's great treasure chests.

Inside story of a fighting gadget

It's not much larger than a hand. You can see that. But this little machine has a big responsibility and packs a lot more than a fistful of wallop.

Its job is moving flaps and shutters on America's fighting planes. It has to be powerful. It has to be light. It has to be compact and super-dependable.

Making it was a big order. The way Lear did it was through sheer engineering ingenuity and almost unheard-of precision in production.

Today this Lear Actuator and the tiny, powerful electric motor that runs it are fighting gadgets. But in the days ahead there should be many important applications for such devices.

So we tell you about them now. Then you will know that such things are available as well as the kind of engineering thinking and production technique that made them possible.

PLANTS: Flushing, N.Y., and Grand Rapids, Mich.
BRANCHES AT:
New York, Los Angeles, Chicago, Detroit, Cleveland.



Formerly Lear Avia, Inc.

For You—The World's Clearest Most Beautiful Radio Tone in Your **COMING NEW ZENITH** **RADIONIC *FM* RADIO**

Zenith's Specialization in "RADIONICS EXCLUSIVELY"

*will bring you Genuine FM at its finest in
radios and radio-phonographs!*

GENUINE ZENITH Radionic FM is an utterly different *kind* of radio. It will bring into your home a tone unlike anything you've ever heard before.

It will open up to your ears an entirely new range of richness, and fullness, and color... entirely free from static noise at all times... so thrillingly real that you'll swear the performers in the studio or on records are right in the room with you!

FM's development is an important part of RADIONICS, the vast new science in which many discoveries are so sensational they cannot yet be disclosed to the public.

Zenith, world's leading specialists in "RADIONICS EXCLUSIVELY," will bring you *genuine* FM, not an imitation. And it will be Zenith Radionic FM, born of the world's longest, broadest, most intensive experience in the field of HIGH FREQUENCY!

You see, Zenith pioneered this field. It was Zenith that years ago introduced short wave communication into the U. S. Navy, and has been developing Short Wave FM and Television since their very birth!

Among the world's first and finest FM stations, for example, is the transmitter created and operated by Zenith in Chicago. And Zenith has never scattered its energies over unrelated fields such as refrigerators, washing machines, cooking ranges, vacuum cleaners. They have specialists of their own. Zenith concentrates its leadership in engineering and precision manufacture on "RADIONICS—AND ONLY RADIONICS!"

This is the big reason why you will enjoy the world's clearest, most beautiful radio tone in the coming new Zenith Radionic FM Radios and Radio-Phonographs... the reason they will combine advanced engineering and precision quality at low cost, as never combined before!

The day radios are again available for your home, it will pay you to be smart—to put *your* money on a winner. Keep your eye on Zenith for genuine FM at its finest—and see Zenith first!

Available now for America's hard-of-hearing—the famous new Zenith Radionic Hearing Aid. Only \$40 complete, at authorized Zenith Hearing Aid dispensers.

COPYRIGHT 1945, ZENITH RADIO CORP., CHICAGO, ILL.

Keep Your Eye on

ZENITH

LONG DISTANCE RADIO

for the Best in Radio!

RADIONIC PRODUCTS EXCLUSIVELY—
WORLD'S LEADING MANUFACTURER

RADIO • FM • TELEVISION • RADAR • SHORT WAVE • RADIO-PHONOGRAPHS • HEARING AIDS

EXCITING AS THE RACE IN "BEN HUR"!

THERE was an expectant hush. Then, out of the darkness of this June night in 1908, flashed a scene of breath-taking action.

A "spectacular" sign had been erected on the old Wonderland Building, to give Detroit its first glimpse of the Model "T" Ford.

"Watch the Fords go by!" the message read. And in the light and color of 2000 twinkling electric bulbs, a Ford touring car appeared to race along the Grosse Pointe shoreline. The wheels turned, scuffing up clouds of dust. The scenery shifted constantly. The veils of the women passengers streamed in the breeze. The

crowd in the square began to cheer. "It's exciting as the race in 'Ben Hur'," said an onlooker. The newspapers thought so, too.

"Hour after hour," wrote one reporter, "the auto hurried, defied speed and natural laws alike, every instant seemingly on the verge of tipping into space down in the street below."

From that far-off day to this, people have continued to "watch the Fords go by". They have watched the total mount to 1 million in 1915—to 15 million in 1927—and on up to 30 million.

They have seen these Ford cars and trucks shrink distances and

help increase the productivity of the nation. They have seen them wipe out the traditional barriers between city and country, between mountain and plain, and help spread the advantages of American culture and opportunity.

One day, there will be new Ford, Mercury and Lincoln cars. Like their predecessors, they will benefit by the energetic skills and resourceful engineering which are a Ford trade-mark. They will be exceptionally comfortable cars, reliable and economical... priced within reach of the greatest number. *Their styling will be so advanced that it will be a perfect match for their quality leadership.*

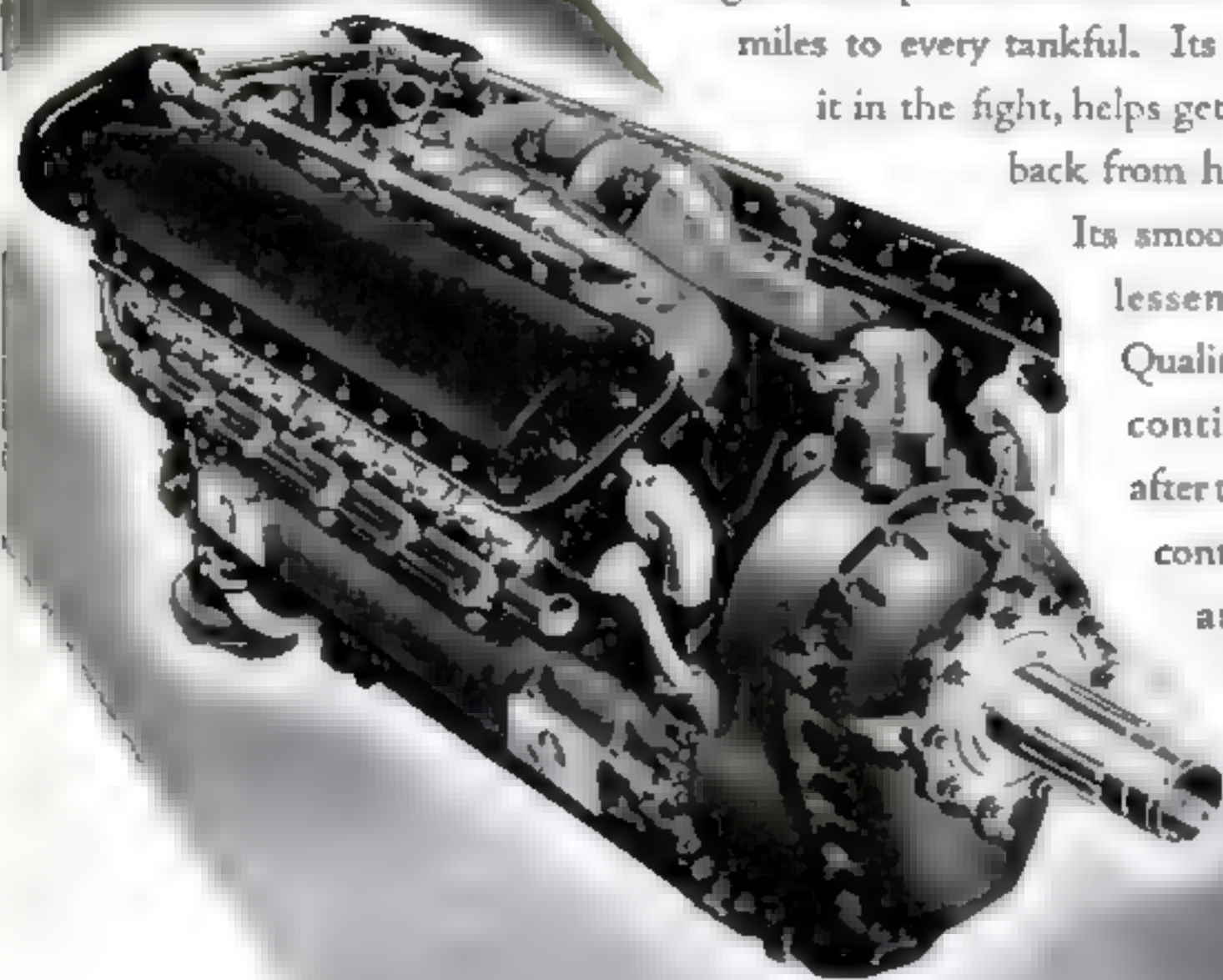
FORD MOTOR COMPANY



TO FIGHT THERE AND BACK

In this war pilots often fight far over enemy territory, hundreds of miles from their base. So fighter planes need range as well as sting. ★ In such sorties the Allison engine has proved its mettle. Its economy adds miles to every tankful. Its dependability keeps it in the fight, helps get both plane and pilot back from hazardous encounters.

Its smoothness and response lessen pilot fatigue. ★ Qualities like these will continue in importance after the war's end. They will contribute to the comfort and safety of your flights in the days of great air transport to come.



POWERED BY ALLISON

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
A-36 and P-51—Mustang
P-63—Kingcobra

More than 60,000 Allison engines have been built for the army planes of the U. S. Army Air Forces.

LIQUID-COOLED AIRCRAFT ENGINES

Allison

DIVISION OF

Indianapolis, Indiana

Every Sunday Afternoon

GENERAL MOTORS SYMPHONY OF THE AIR—NBC Network



**KEEP AMERICA STRONG
BUY MORE WAR BONDS**

Screwball ideas on battery care



Pinkerton Snord is really in a jam, now. Thought he could save his battery by driving with his parking lights. Now see what's happened! It's no use, Pinkerton. There's only one sensible way to save your battery.

...the wise way is PERIODIC RECHARGES!

Lots of batteries grow weak and feeble when rationed gasoline cuts driving down. Yet you needn't get caught with a battery gone "dead." Drive in to your Exide Dealer occasionally for a **FREE CHECK UP!** When necessary, he'll advise recharging to keep your battery strong. **PERIODIC RECHARGES** cost little, but they postpone the day when you'll need a new battery. When that day comes, get a dependable, long-lasting Exide.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

EXIDES ARE USED IN MORE THAN 100
APPLICATIONS BY OUR ARMED FORCES

DECEMBER, 1944

Buy War Savings Bonds and Stamps regularly.

237



THERE'S BEEN A BIG CHANGE



★ The dapple grays have disappeared from Main Street. More efficient, motorized equipment has taken over the job of fighting fires.

Tapered roller bearings have been improved, too—made more efficient by Tyson's "All-Rolls" design. Tyson's extra load-

carrying rollers mean added capacity—longer bearing life—maximum rigidity.

In transportation, industry, agriculture—wherever the going is tough—Tyson's unusual performance is a matter of record.

The big name in bearings today is ... TYSON!



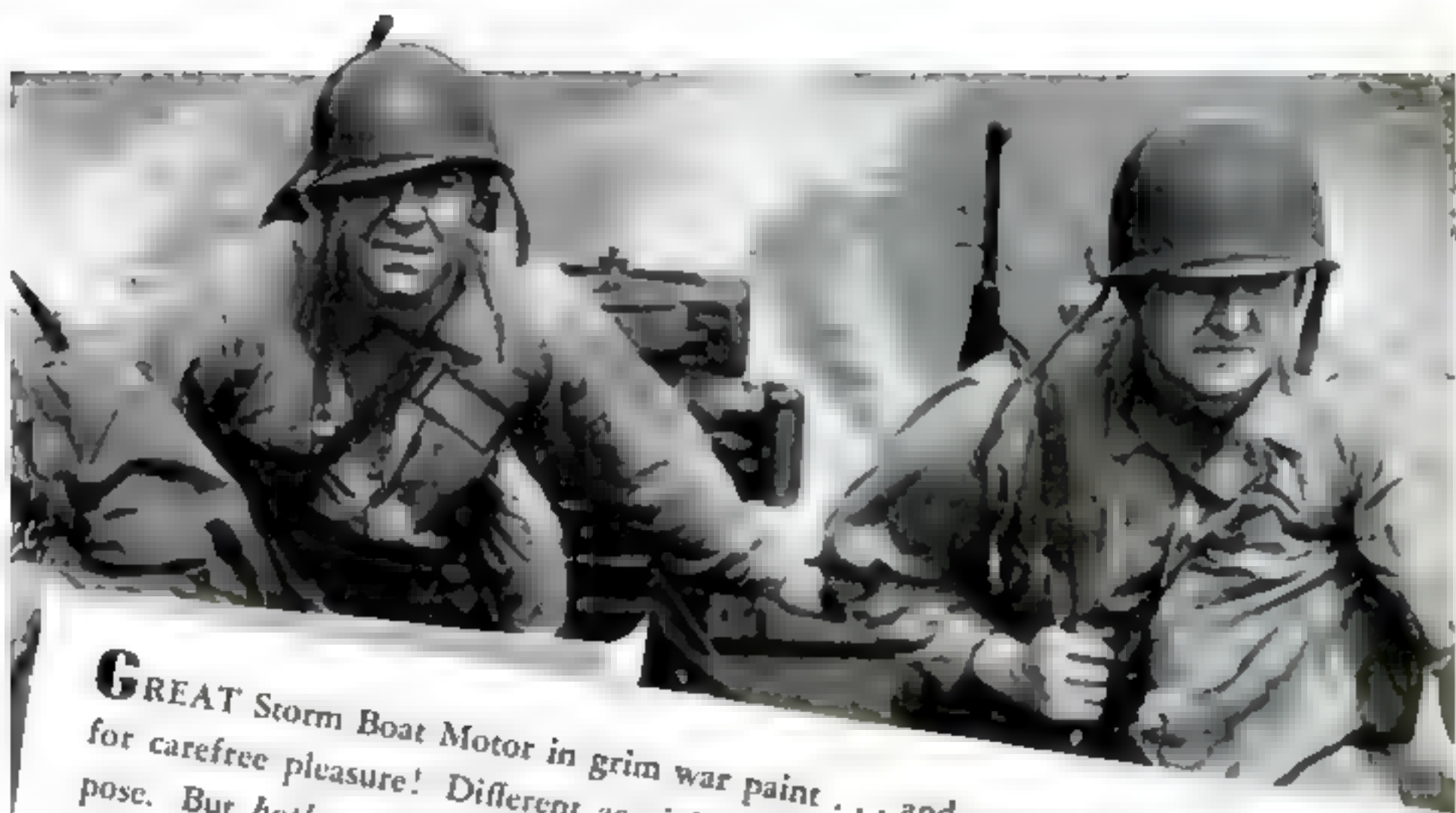
TYSON BEARING CORPORATION, MASSILLON, OHIO



Tyson

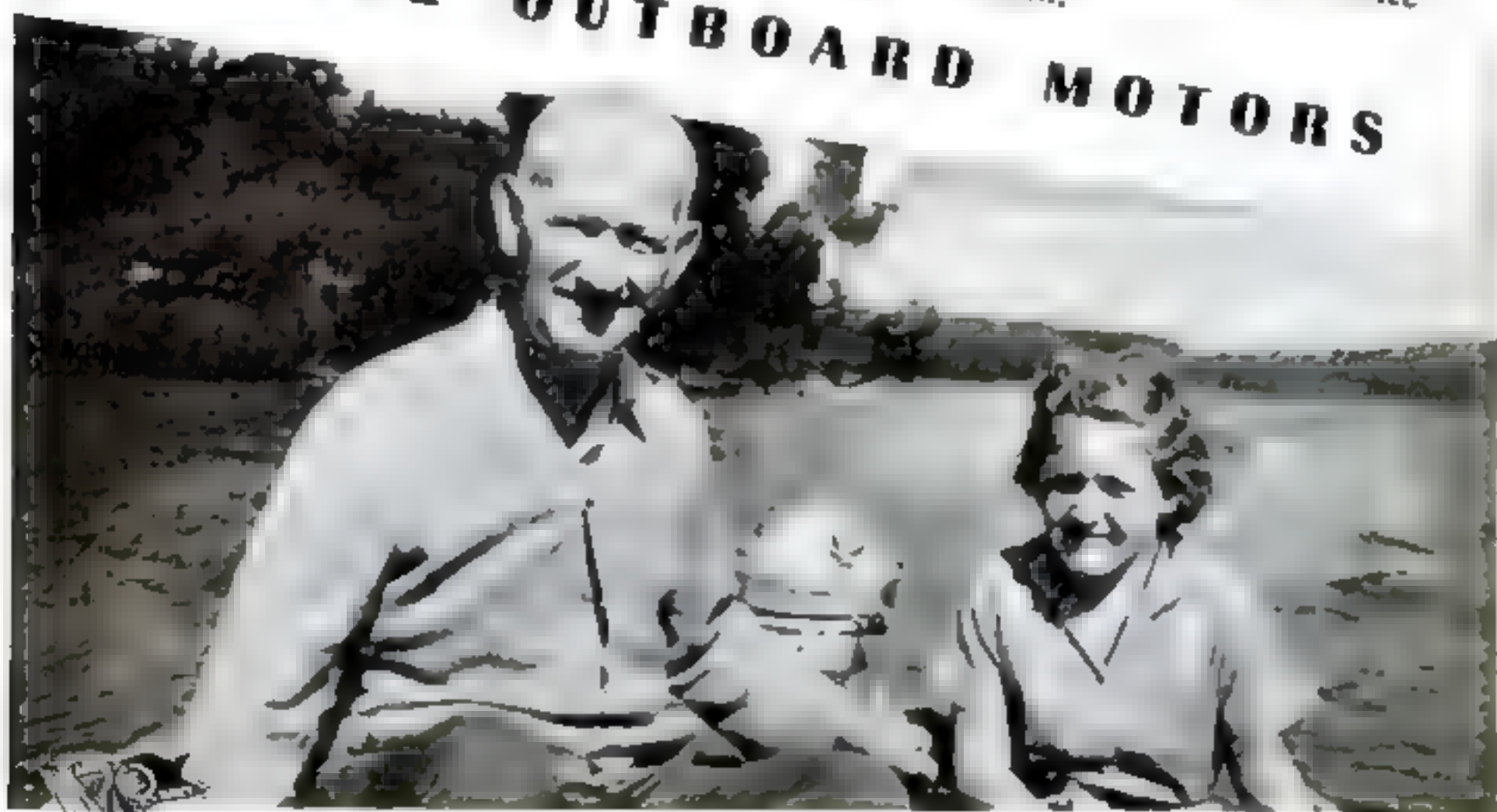
TODAY'S HEAVY-DUTY BEARING

★ BUY MORE WAR BONDS ★



GREAT Storm Boat Motor in grim war paint . . . and sparkling little outboard built for carefree pleasure! Different as night and day they are, in size and power and purpose. But *both are Evinrudes* . . . as alike in basic characteristics as peas in a pod. Each reflects the advancements achieved during more than three decades of outboard pioneering, intensive research, tireless engineering. Above all, each is built to deliver the *top level of unfailing reliability* in every phase of performance. And nothing else is so important . . . either in a motor destined for relentless combat duty . . . or in the new outboard you look forward to owning when motors for happy peacetime service are again available. *Evinrude Motors, Milwaukee 9, Wisconsin.*

EVINRUDE OUTBOARD MOTORS



EVERY DOLLAR YOU INVEST HELPS SPEED VICTORY . . . BUY MORE BONDS

Avoid a winter of *Shivery Shaves*



**KEEP YOUR HOME WARMER WITH
BALSAM-WOOL ATTIC INSULATION!**



Bathroom chilly in the morning? Dining room frigid? You'll have more warmth in every room—and you'll save up to 20% in fuel—by applying Balsam-Wool Attic Insulation right now!

Balsam-Wool, you see, stops heat leakage—conserves your comfort. And it keeps on doing that worthwhile job year after year because it is made to *last*—designed to be windproof, moistureproof, fire resistant and highly efficient. Easy to apply—laid just like a rug in your attic. Because it gives proved protection, Balsam-Wool is sold under a Money-Back guarantee of complete satisfaction.

You can do this job right now and have a warmer, more comfortable house, plus lower fuel bills for the rest of the winter and all the winters to come. See your **lumber dealer** or mail coupon.

Balsam-Wool

SEALED INSULATION

Balsam-Wool... Products of Weyerhaeuser... Nu-Wood

WOOD CONVERSION COMPANY
Dept 211-12, First National Bank Bldg
St. Paul 1, Minnesota

Gentlemen, I want to know more about Balsam-Wool Double-Value Atch Insulation.

To assist us in giving you special information, please check I am a home owner ☐
renter ☐ architect ☐ contractor ☐
student ☐ postwar planner ☐

News

Abstract

City	State
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64

State



**SHARPEN
YOUR
DRILLS**
with the
**E - Z
DRILL
SHARPENER**

**ONLY
\$1.98**

老田村有一
個小水庫



**WILL SHARPEN ALL ROUND SHANK
DRILLS FROM THE SHORTEST TO
11" LONG— $\frac{3}{16}$ " to $1\frac{1}{2}$ " DIAMETER**

This precision fixture is real shop size, sturdily built, attaches to bench or grinder frame. Thousands in use—home and repair shops, garages, factories, farm shops—wherever accurate holes are drilled, E-Z is simple to operate. Already set for 59° drill angle, no adjustment needed for 99% of drills. Gives fast drilling, perfect hole centers and clearance. Guaranteed to do the work. **SAVE MONEY WITH E-Z.** Comes complete with instructions, ready to sharpen your dull drills as good as new, low price of \$1.98 because of our volume business on this wanted precision tool. Send check or money order for \$1.98. **WE PAY POSTAGE AND SHIP IMMEDIATELY. ORDER NOW!**

FRED F. TEN EYCK

Dept. 52, 758 S. 19th St.

Los Angeles 5, Cal.

DE LUXE MODEL NO. 2 Features include: 100% American made; 100% plastic body; 100% metal parts; 100% metal springs; 100% metal hinges; 100% metal fasteners; 100% metal hardware; 100% metal trim; 100% metal finish; 100% metal paint; 100% metal color; 100% metal texture; 100% metal grain; 100% metal pattern; 100% metal design; 100% metal style; 100% metal taste; 100% metal smell; 100% metal touch; 100% metal feel; 100% metal sound; 100% metal sight; 100% metal thought; 100% metal feeling; 100% metal thinking; 100% metal acting; 100% metal reacting; 100% metal responding; 100% metal interacting; 100% metal communicating; 100% metal connecting; 100% metal relating; 100% metal associating; 100% metal comparing; 100% metal contrasting; 100% metal combining; 100% metal mixing; 100% metal blending; 100% metal merging; 100% metal joining; 100% metal bonding; 100% metal fusing; 100% metal welding; 100% metal soldering; 100% metal brazing; 100% metal casting; 100% metal forging; 100% metal forming; 100% metal shaping; 100% metal molding; 100% metal machining; 100% metal manufacturing; 100% metal production; 100% metal processing; 100% metal fabrication; 100% metal construction; 100% metal building; 100% metal creating; 100% metal making; 100% metal doing; 100% metal having; 100% metal being; 100% metal existing; 100% metal living; 100% metal dying; 100% metal sleeping; 100% metal waking; 100% metal eating; 100% metal drinking; 100% metal breathing; 100% metal moving; 100% metal staying; 100% metal going; 100% metal coming; 100% metal returning; 100% metal leaving; 100% metal arriving; 100% metal departing; 100% metal exiting; 100% metal entering; 100% metal passing; 100% metal crossing; 100% metal touching; 100% metal meeting; 100% metal greeting; 100% metal saying; 100% metal speaking; 100% metal talking; 100% metal listening; 100% metal hearing; 100% metal seeing; 100% metal watching; 100% metal observing; 100% metal noticing; 100% metal realizing; 100% metal understanding; 100% metal knowing; 100% metal learning; 100% metal teaching; 100% metal studying; 100% metal reading; 100% metal writing; 100% metal drawing; 100% metal painting; 100% metal sculpting; 100% metal dancing; 100% metal singing; 100% metal playing; 100% metal working; 100% metal playing; 100% metal resting; 100% metal relaxing; 100% metal enjoying; 100% metal loving; 100% metal hating; 100% metal liking; 100% metal disliking; 100% metal preferring; 100% metal choosing; 100% metal deciding; 100% metal determining; 100% metal concluding; 100% metal summarizing; 100% metal reviewing; 100% metal evaluating; 100% metal assessing; 100% metal analyzing; 100% metal synthesizing; 100% metal interpreting; 100% metal explaining; 100% metal describing; 100% metal defining; 100% metal identifying; 100% metal recognizing; 100% metal remembering; 100% metal forgetting; 100% metal imagining; 100% metal fantasizing; 100% metal dreaming; 100% metal wishing; 100% metal wanting; 100% metal needing; 100% metal requiring; 100% metal demanding; 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With this NEW TOOL (not a brush) everyone can now draw like a professional. The only difference is you'll be able to draw like a professional. The only difference is you'll be able to draw like a professional. The only difference is you'll be able to draw like a professional.

Seed only 7¢ 50 for complete tool for peeling a 1/2" wide straw, in-
cluding adhesive glue. Contains instruc-
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As easy to use
as a pencil

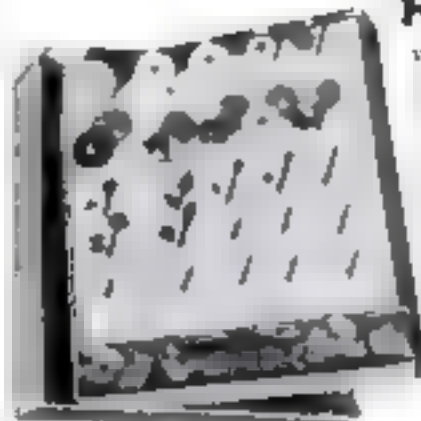
Every Painter and Craftsman Should Own One
 It's for your job and an extra profit and a little extra speed today. It's for you and your business. It's for your work and your money. It's for your pride and your reputation. It's for the fact and we'll refund your money if you don't like it.

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This is a message to our fighting men everywhere. Even though the war has cut into your normal way of living—back home, the things you cherish most remain unchanged. America's broad highways, its woods, rivers, mountains and wide stretches of open country are as inviting as ever—waiting for you. They are as constant as your yearning for the thrill of enjoying them again — on a Harley-Davidson!

Yes, thanks to you, the days will come again when red-blooded motorcycle fans can take in race meets, hillclimbs, endurance runs, pleasure trips and all other fun-packed motorcycling events. Plan to be riding with the rest of the gang on a brand new Harley-Davidson Motorcycle!

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Please send at once free copy of 24 page
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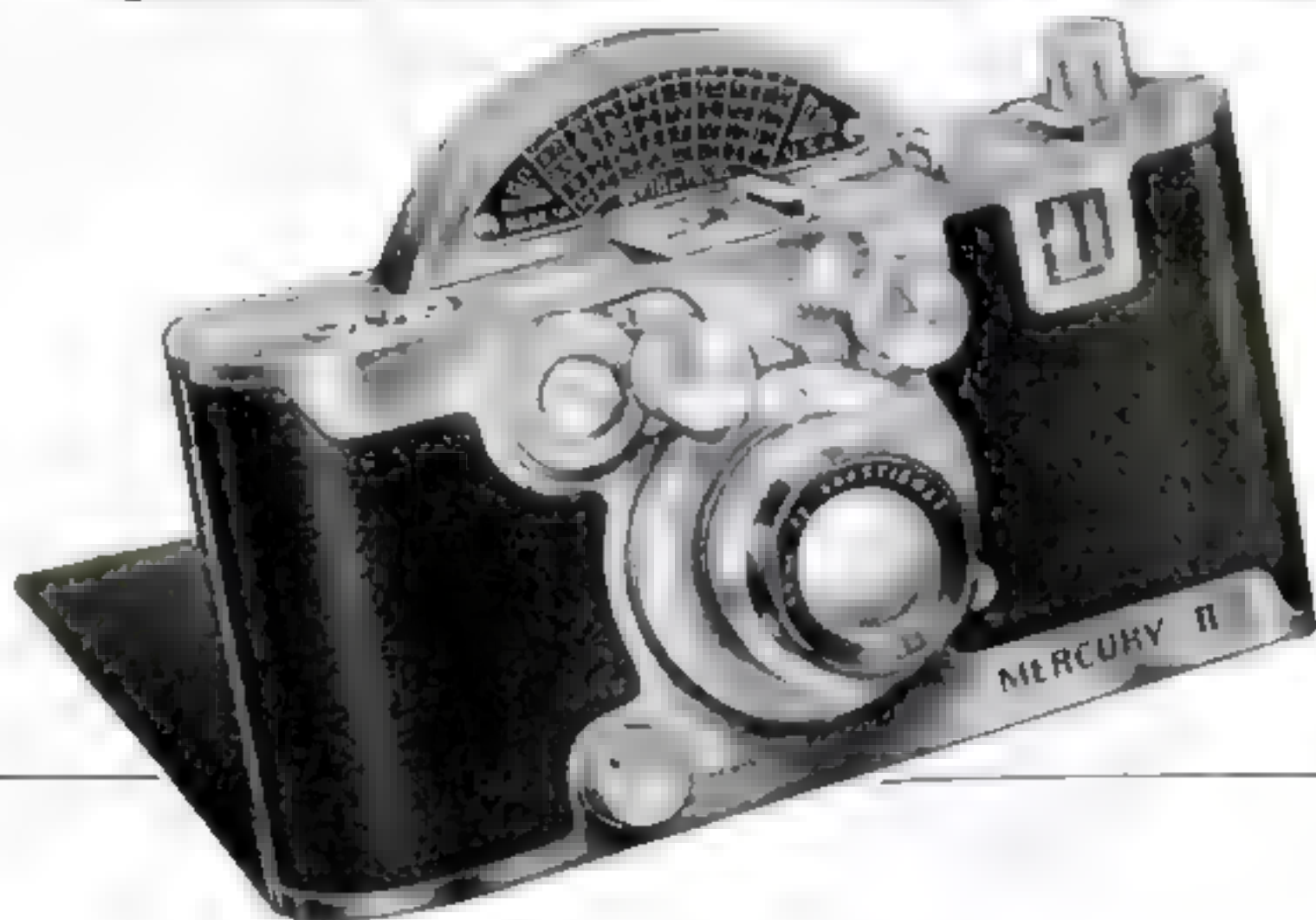
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Preview

OF THE WORLD'S FIRST CANDID CAMERA
specially designed for today's color films



THE UNIVERSAL MERCURY II

IT TAKES the guesswork out of color photography — this new MERCURY II, with interchangeable high-speed and telephoto lenses. Color shots are better — they're sharp and color-true in every part of the picture. MERCURY II will be one of the fastest candid cameras

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Soon you will be able to buy the famous 8mm. Cinémaster Movie Camera and Projector.

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Preview Announcements of a complete line of Cinémaster Home Movie Equipment.

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Because nothing rolls like a ball...

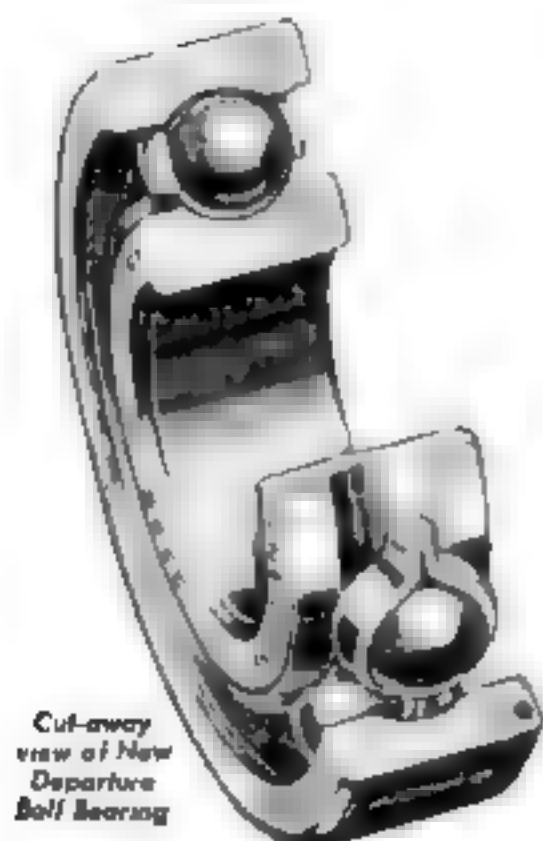
The Steel Ball, precision-ground and lapped to within five *one-hundred thousandths* of an inch of perfection in diameter, is the heart of the New Departure Ball Bearing.

The New Departure Ball Bearing is the heart of much that moves or rolls—in peace, as well as in war.

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New Departure's experience, resources for research, imagination and advanced techniques have produced a truly fine ball bearing.

So . . . when next you buy or build some mechanical device, ask: "Has it New Departure Ball Bearings?"



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IN PEACE as in WAR OUR BUSINESS IS SAVING LIVES!



Ta-Pat-Co life-vests—that even bullets could not sink—have been in the war

Before long, Stay-A-Float will again make swimming and boating safe for Johnny and Jane.



Safe sleep went into the jungle with this specially designed hammock. To be yours with peace.

Adrift at sea or sailing the lake . . . in stinking jungle or pine-scented woods . . . in Arctic wastes or beneath stars on a stream . . . a life is still a life and just as precious.

Because lives *had to be saved*, Ta-pat-co turned every ability and facility it possessed to war production. When the sea threatened, Ta-pat-co was there . . . *ready*. When the Arctic's icy cold swept down, Ta-pat-co was there . . . *ready*. When the stinking jungle sought to spread its pestilence, Ta-pat-co was there . . . *ready*. For Ta-pat-co's business is to be there . . . *ready* . . . where there are lives to be saved.

Soon, as war's debris is cleared away, Ta-pat-co will again be able to go where you go . . . be ready again to help meet your emergency when it comes . . . be ready to provide again safety and security for your outdoor activity.

FREE



OUTDOORS WITH TA PAT-CO

This famous book is as entertaining to you who know the answers as it is helpful to those who don't. How to call wild ducks without a call—hunt rabbits without a gun—and 100 other do's and don'ts. New postwar edition now ready for the press—better put your name in now for a first copy. No charge.

Tapatco

THE AMERICAN PAD & TEXTILE CO., GREENFIELD, OHIO



OWI photo from Signal Corps

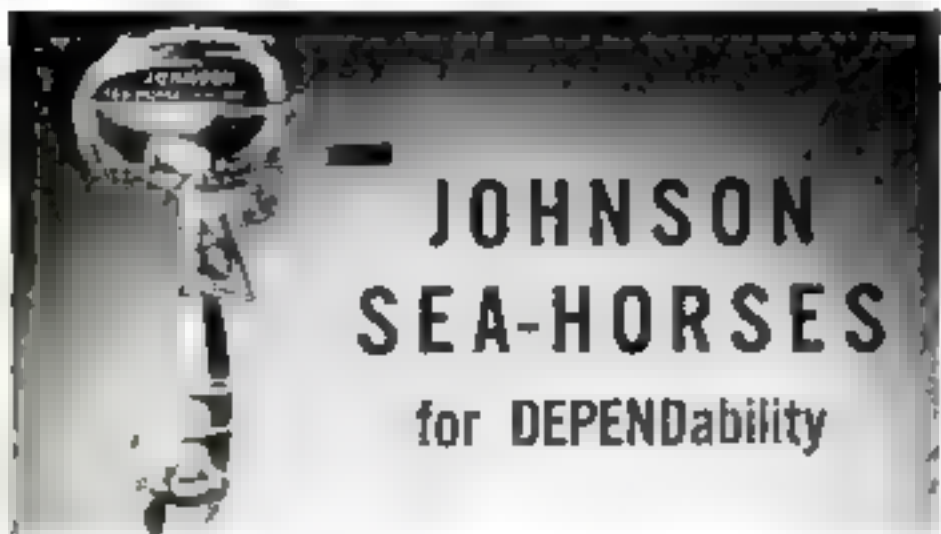


TODAY

Johnson Sea-Horse outboard motors are made only for the armed services and essential needs. This photo shows the Sea-Horse at war in the European theatre.

TOMORROW

Johnson Sea-Horses will serve mankind in rehabilitating tired minds and bodies. They will bring fun and peace and happiness to thousands of war-weary.



ALWAYS

In war or peace, the Sea-Horse is notable for its **DEPENDability**—the result of millions of man-hours of experience in the manufacture of outboard motors. *There is no substitute for experience!*

DEALERSHIPS: If you are interested in selling AND SERVICING outboard motors after the war, write us—no matter what your location may be.
JOHNSON MOTORS, WAUKEGAN, ILLINOIS

DO YOUR DUTY—



BUY WAR BONDS

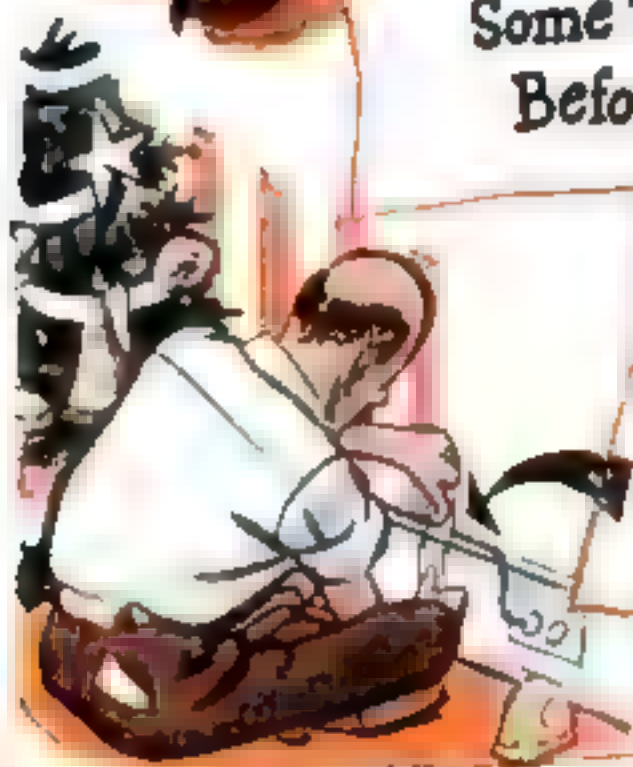


When wrapping Christmas packages
Smart givers often choose
To brighten them with Texcel Tape—
It's made in many hues.

And if a candle breaks in two
Or wobbles in the holder,
Some Texcel Tape will fix it up
Before you're seconds older.



So many things this Texcel does
On joyous Christmas day,
From hanging wreaths to holding wires
Safely out of way.



For Texcel is an improved tape
Whose "stick-um's" bonded on.
It won't come off, it won't dry out,
It's one, like grass and lawn.

Today most Texcel Tape that's made
Is being used for war.
Buy Bonds and Stamps 'til Victory
Returns it to your store.



Made by
Industrial Tape Corporation
A Division of
Johnson & Johnson
New Brunswick, N.J.

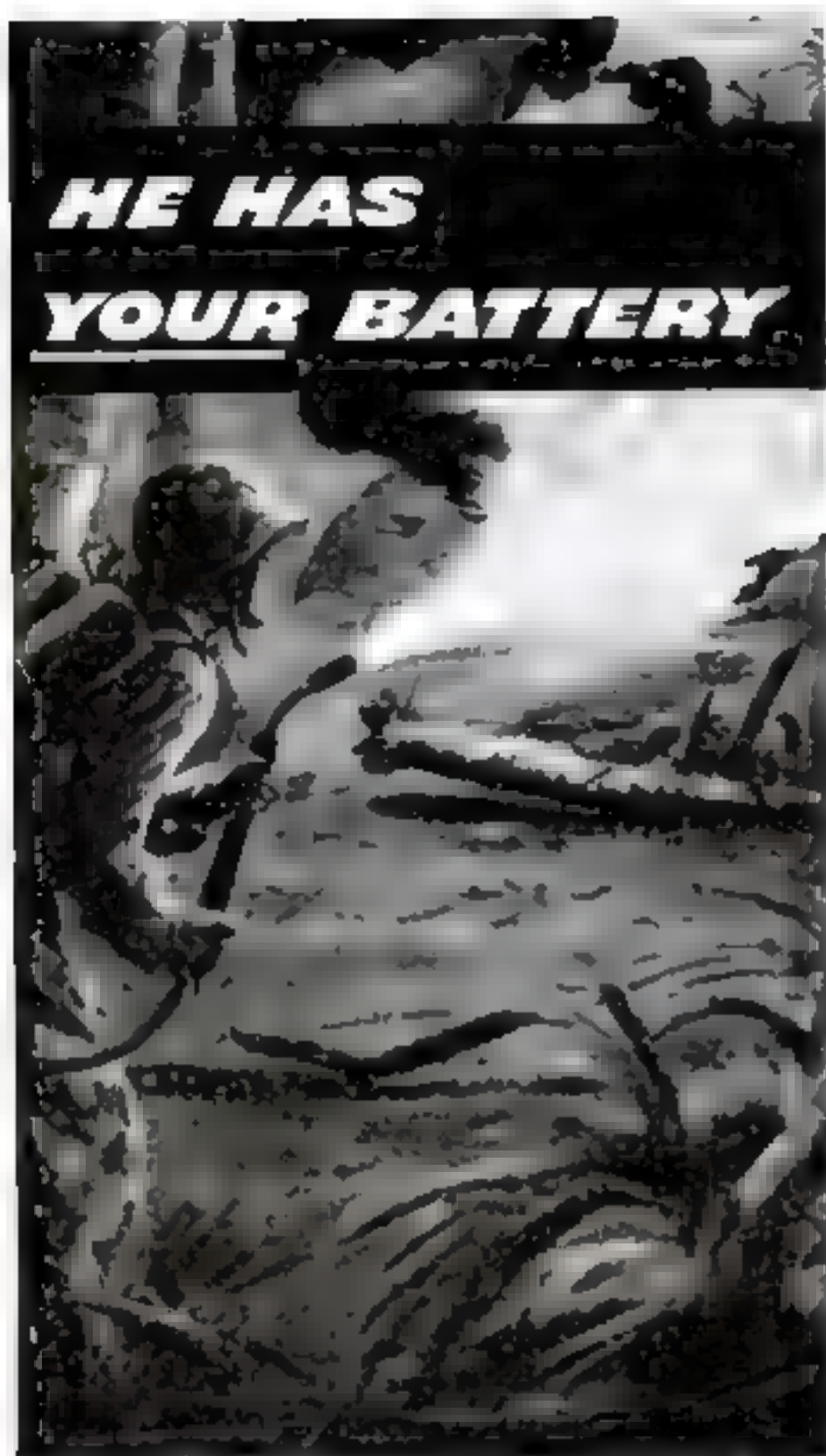
Texcel Tape

CELLOPHANE TAPE — STICKS WITH A TOUCH

DECEMBER, 1944

Buy War Savings Bonds and Stamps regularly

245



HE HAS YOUR BATTERY

Deadly flamethrowers are blazing the road to Victory! Each of these efficient weapons depends upon dry batteries to spark the flame for instant action. The batteries you do without mean more fire-power for frontline fighting men. Use your available batteries sparingly...keep them cool and dry...rest them as often as possible. For Free Battery Hints—Write Dept. E-4, Burgess Battery Company, Freeport, Illinois.

At least one extra for the SIXTH!



**BURGESS
BATTERIES**
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REFINISHING HINTS

Here's already-colored wax
in **HARD-TO-GET COLORS**



• If you've got a nick or scar to cover in a table top...or want to bring back the rich, mellow finish on an old piece of cherry, maple, or pine furniture...or finish a repaired section to match older wood...here's an assortment of colored waxes all ready to use.

Shinola Wax Shoe Polish in Neutral, Brown, Ox-blood, and Black, applied and finished like any other wax, is also grand for models, leather and linoleum. And remember—Shinola helps keep shoes new-looking longer.

KEEP 'EM SHINING WITH
SHINOLA



Wartime places heavy demands upon our supplies, so if your dealer is temporarily out of stock, please be patient.



NEUTRAL - TAN - BROWN - OX-BLOOD - BLACK

NO  **MIXING**
NO  **HEATING**
with **FRANKLIN**
Liquid Hide
GLUE

**NO
CHILLED
JOINTS**

"EVERY
DROP
WORKS"

AT YOUR HARDWARE DEALER
Or Send 30 Cents for 1/4 Pint to
The Frank n Glue Co., Columbus 3, Ohio



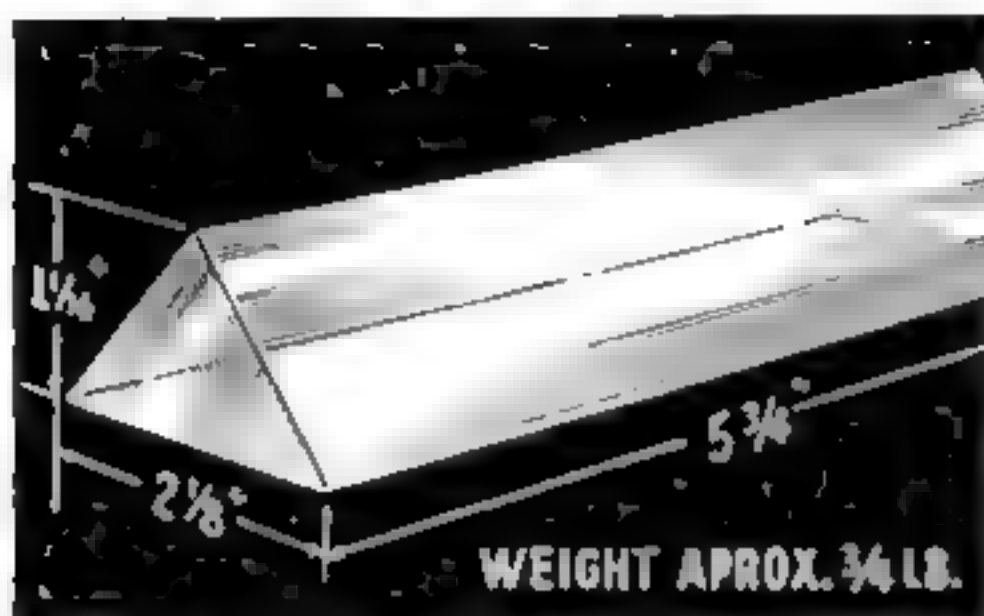
SENSATIONAL WAR BARGAINS IN LENSES & PRISMS

OUR ITEMS MAKE EXCELLENT CHRISTMAS GIFTS—
All Neatly Packed and Marked

YOU CAN EASILY MAKE

Telescopes Magnifiers Photographic Gadgets
and HUNDREDS OF EXPERIMENTS with these Low Cost LENSES

All Lenses New, Finely Ground and Polished, Edges Very Slightly Chipped—A Salvage Bargain!



TANK PRISMS

In order that the tank driver shall not get shot in the face, two of these Silvered Prisms are used to make a periscope. We have secured a number of these that are very slightly chipped, making possible their sale at a very low price. They are 90-45-45 degree prisms of huge size—5 3/4" long, 2 1/8" wide, finely ground and polished. You can use these Prisms to make Periscopes to see over the heads of crowds, to photograph fish under water, to view high or low gauges, etc. Also excellent for experiments, classroom demonstrations at high schools, colleges, camera clubs, astronomy clubs. Some of our ingenious customers have used these Prisms to make camera stereo attachment, photometer cube, range finder, etc. And here's an excellent, unique gift idea. For 5c we supply 100 gold letters with which you can turn one of our Silvered Prisms into a desk name plate in 5 minutes of easy work.

Normally, these Prisms would retail from about \$24 to \$30 each.

Stock No. 3004-N . . . SILVERED TANK PRISM—Price \$2.00 each Postpaid.

Stock No. 3005-N . . . PLAIN TANK PRISM—Price \$2.00 each Postpaid. This one is excellent for projecting all the colors of the spectrum—a beautiful sight.

FOUR TANK PRISMS—Special—\$7.00 Postpaid
. . . This is the most sensational bargain we have ever been able to offer.

MPG. FOR NAVY'S 7 POWER BINOCULARS

KEILNER EYE-PIECE LENSES . . . you can use in Telescopes, Binoculars, Microscopes etc. Consist of achromatic eye-lens and a field lens. Focal length 27.5 mm. Comes uncemented with FREE cement and easy directions.

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COMPLETE SET OF LENSES AS ABOVE AND THE PRISMS TO MAKE A MONOCULAR (TELESCOPE)

Stock No. 5100-N—Monocular Set \$5.00 Postpaid

ASTRONOMICAL TELESCOPE MIRROR—6" diameter, aluminized, concave for making powerful, color-corrected Telescope. Perfect in every respect. Stock # 5002-N \$49.00 Postpaid

PORRO ABBE PRISMS Stock No. 3006-N . . . 25c each Postpaid. Size 9 mm. by 17 mm. . . . another war bargain. Normal prices would be 10 to 20 times the above quotation.

SPECIALS IN LENS SETS

. . . the unique Xmas Gift, popular with Servicemen! Big 10 Page Project and Idea Booklet with all sets—describes successful developments—points the way to new experiments.

Set No. 301-N "Our Advertising Special" 13 Lenses for \$1.60 Postpaid. For making your own powerful telescopes, low power microscope, strong magnifiers, drawing projector, photo cells, telephoto lens, dummy focusing camera, Kodachrome viewer, stereoscopic viewer, ground glass and enlarging focusing aids. For experimental optics, portraits of babies and small pets, copying, ultra close-up shots, and many, many other uses.

Set No. 305-N "The Gadgeteer's Delight" 35 Lenses for \$5.00 Postpaid. Contains all the lenses in the above set plus twenty more expensive lenses increasing your field of experiment and gadget making. All our lenses are neatly packed and marked.

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New 70-Page Illustrated Idea Book . . . \$1.00 Postpaid.

"Fun with Chipped Edge Lenses" describes a wide variety of uses for our lenses and contains much information especially designed for the homemade construction of optical items.

MAKE YOUR OWN RIFLESCOPE

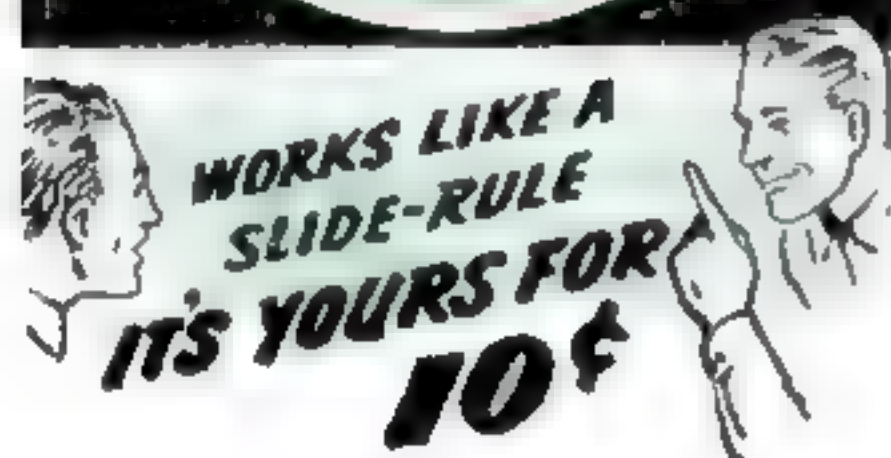
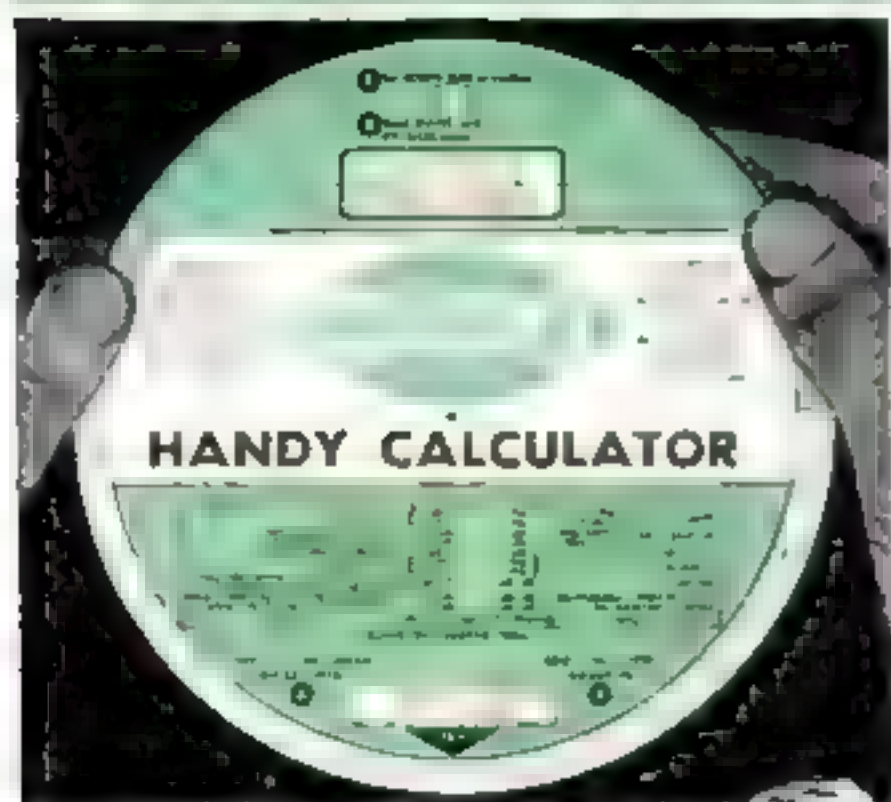
Complete set 5 matched Achromatic Lenses, originally produced for U. S. Navy gunscopes—3 1/2" Power. Order No. 2000-N . . . \$11.00 Postpaid.

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NEW TOOL FOR WOODWORKERS



Solve your woodworking problems with this new GREENLEE Handy Calculator. A fast, easy reading tool, cram-full of valuable data! Helps you convert linear to board feet...find bit sizes for head, body and thread of standard screws...determine nail specifications. You can compare hardness, weights, shrinkage, warping, ease of working of various woods—find slope per foot in degrees. Tool sharpening tips and an accurate protractor, too! Heavy varnished cardboard, 6 inches across, soil-proof, it fits neatly in your tool kit. Don't miss this special wartime offer by the makers of famous GREENLEE tools!



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For This Handy TUBE-BASE CALCULATOR

**SPECIAL
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Here's just the calculator every radio man has been looking for. Easy to use. It tells you quickly tube characteristics that enable you to substitute available tubes for those hard to get. Send for yours today. Address Dept. 8-10. Postpaid, only 25c.

FREE! Giant Radio Reference Map

Here's a gift from Wholesale Radio Laboratories, that you'll want. Size 3½ by 4½ ft. Map has time charts, station list, amateur zones, networks, world shortwave, etc. Yours free. Send 15c to help with mailing and packing. Dept. 8-10.

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New pliable plastic stops heat leaks—saves fuel. Weatherstrips windows, doors, baseboards, casements. Keeps out dust and dirt. Plugs cracks around drainboards, bathtubs, etc.



Use inside or outside. Can be painted.

EASY TO APPLY

Unrolls like ribbon. Just press into place and it stays put. Does not crack, chip or shrink. A roll covers about 80 feet, enough for 5 windows.

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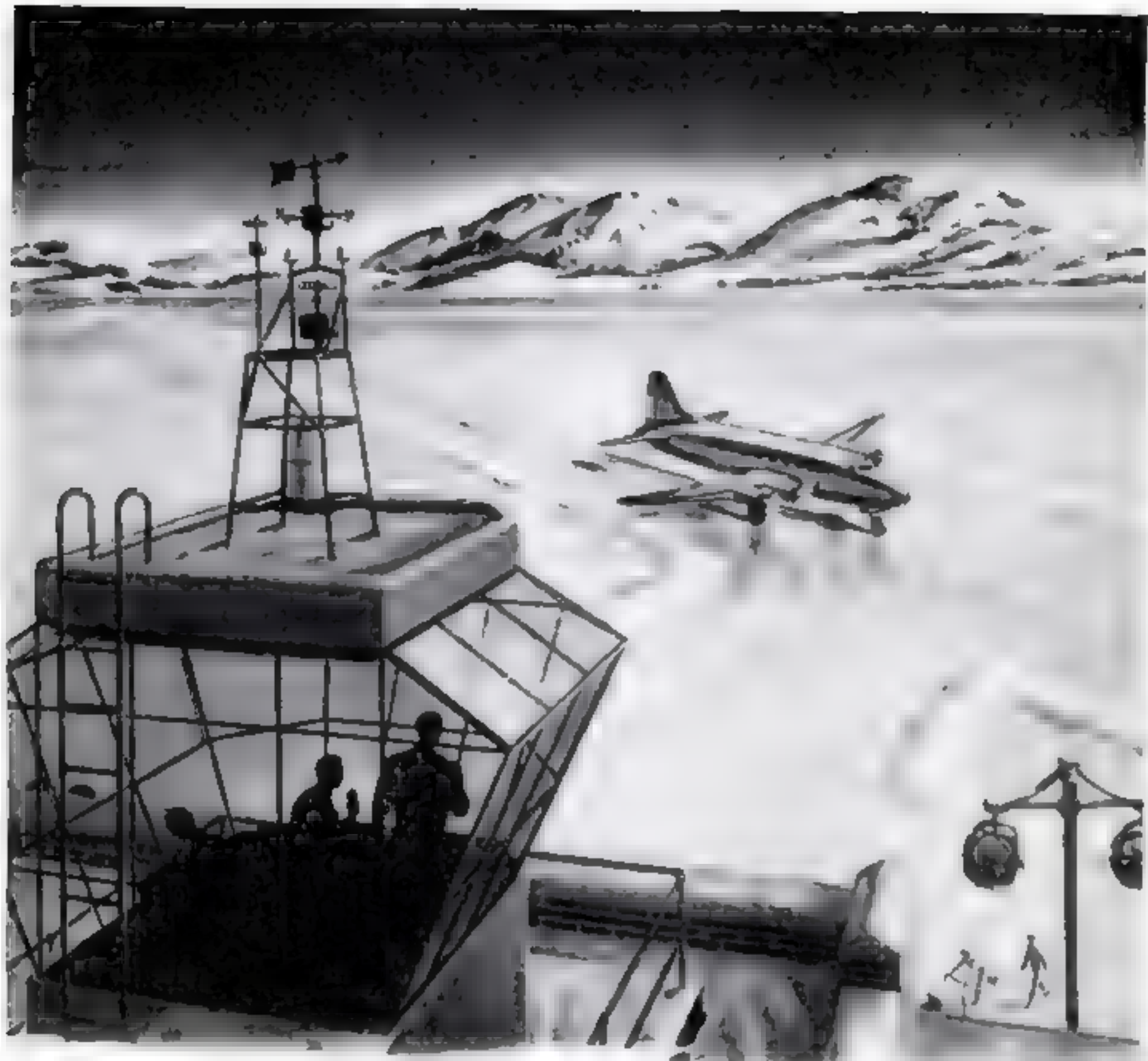
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Now... *Aerodynamic Braking by* **REVERSE THRUST**

Features of Aerodynamic Braking

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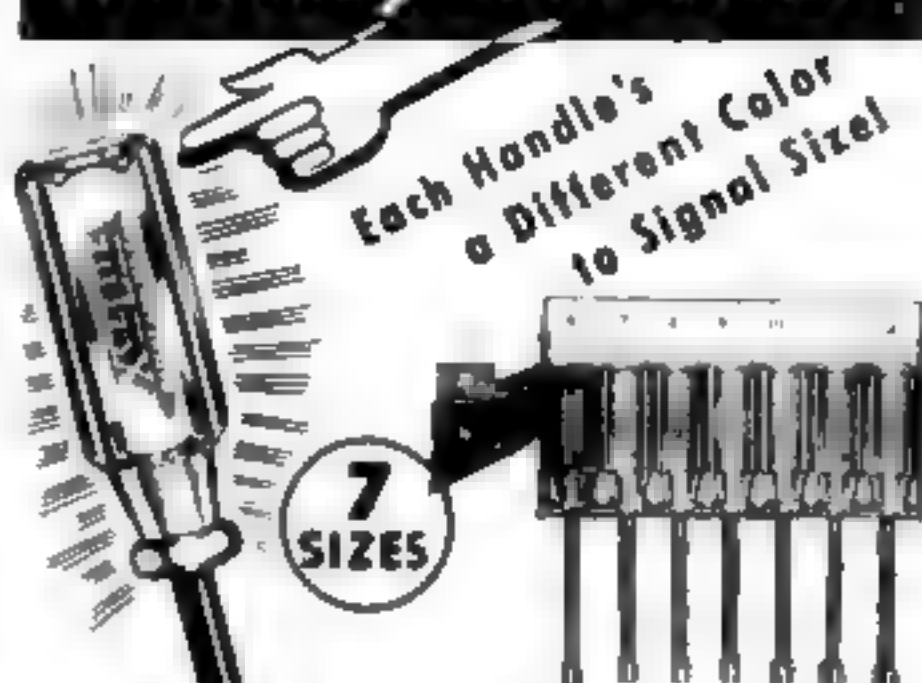
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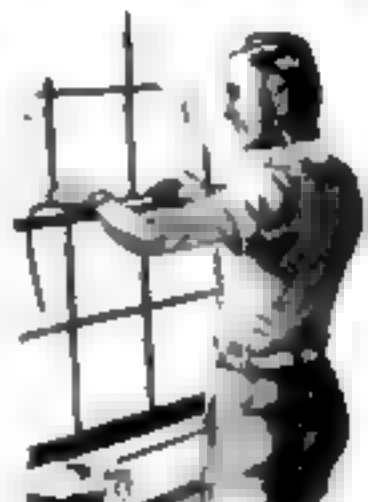
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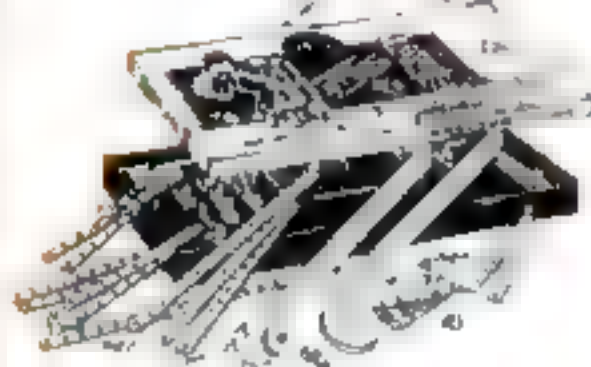
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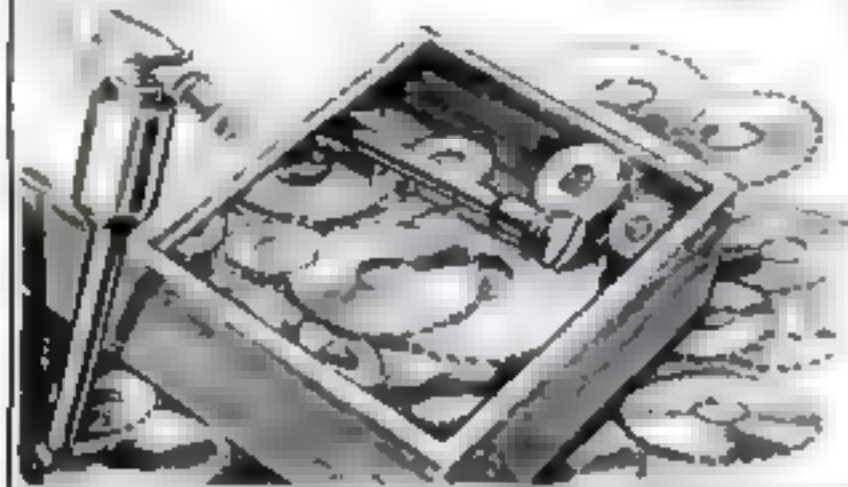
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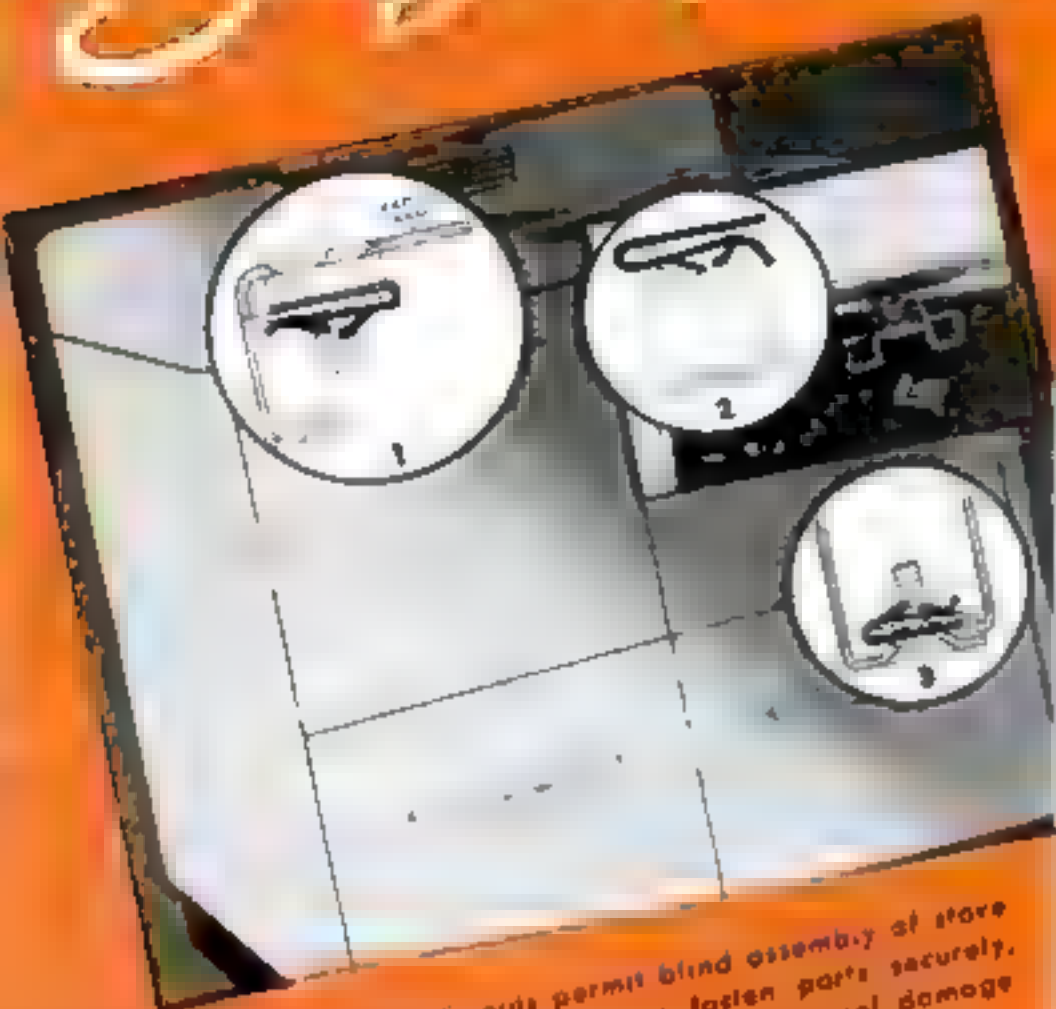
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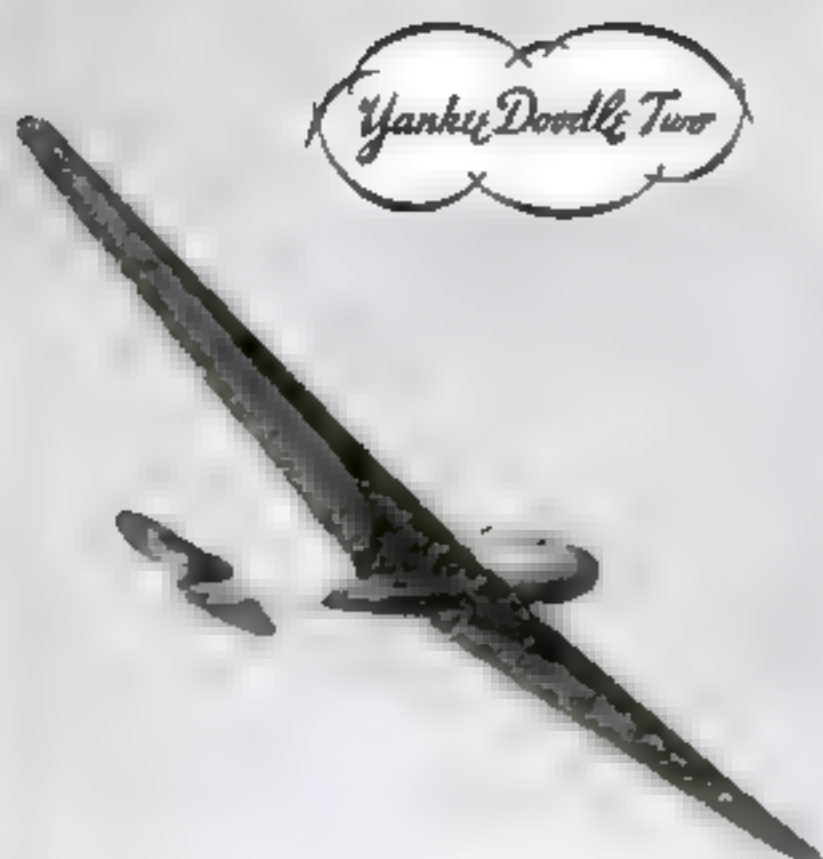
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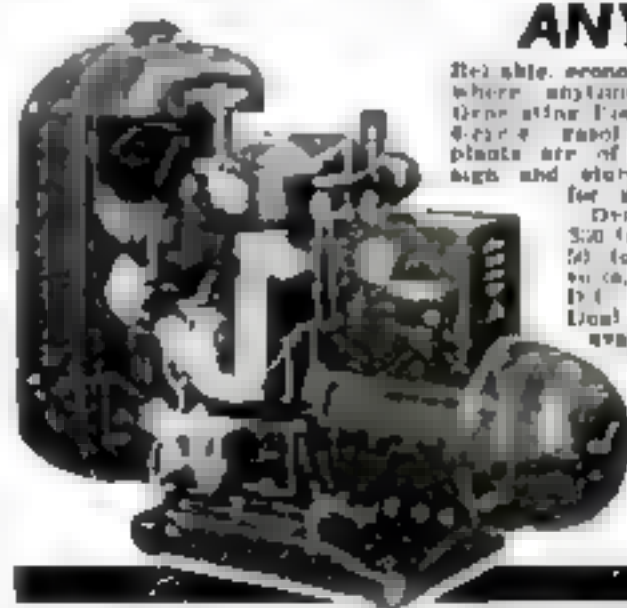
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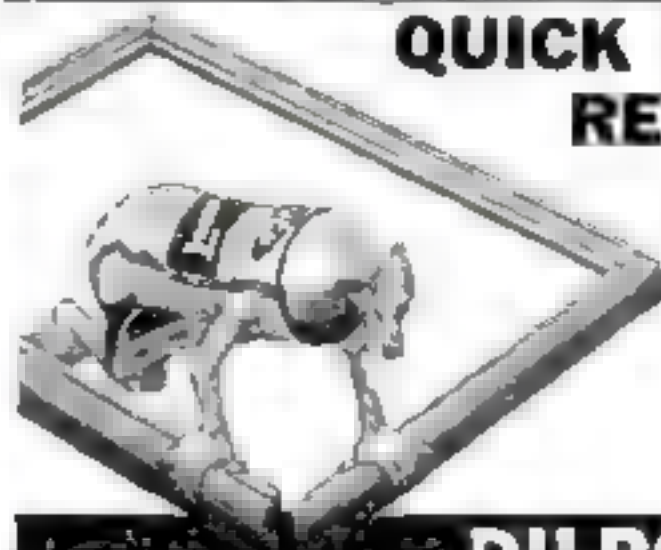
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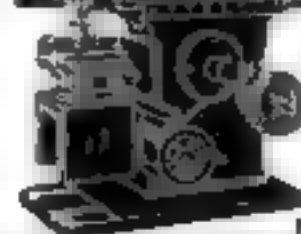
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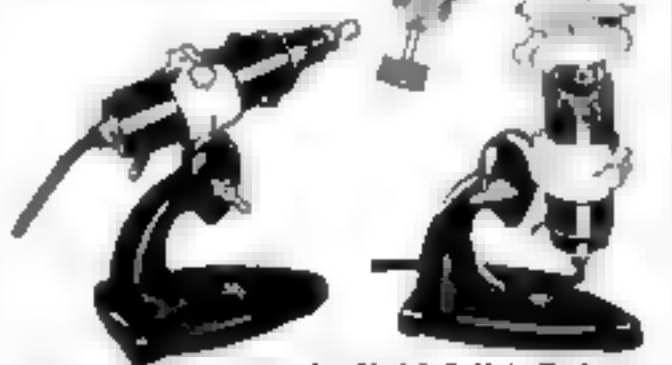
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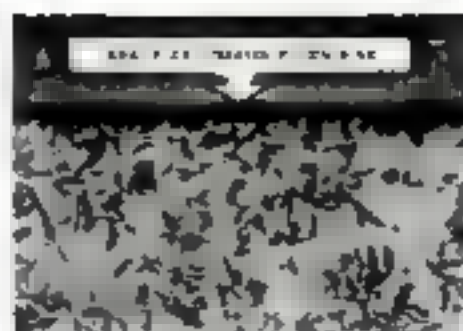
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This photo shows poor distribution of carbon in ordinary cupola iron rings. Note harmful metal particles on ring surface which loosen in cylinders and cause trouble.



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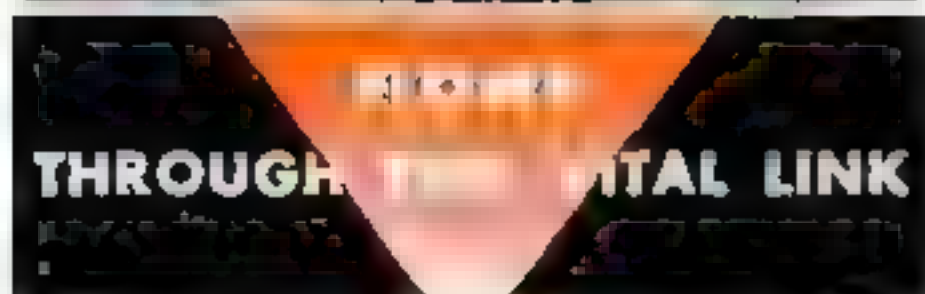
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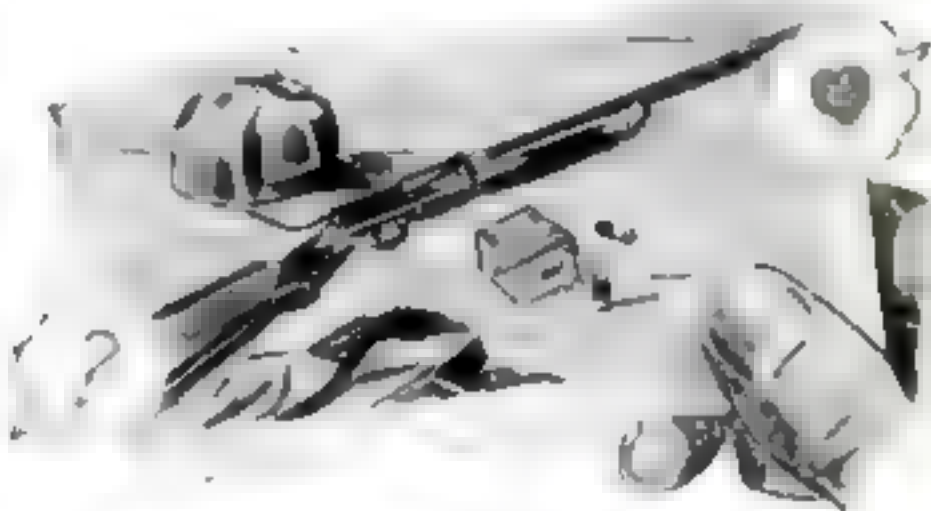
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2 "I FELL IN LOVE with this Remington Sportaman when the Navy issued me one for skeet shooting in anti-aircraft training. I tore this picture out of an ad. I'm going to get one after the war."



3 "LOOK, FRANK," I said, as an idea hit me. "I gotta girl home I hope to marry, too. Sometime after our war job is done, the girls can get together and let their hair down. We'll fill our pockets with some of those long-range Remington Express shells and go hunting." "Sold!" said Frank. So now that's one of our important postwar objectives.

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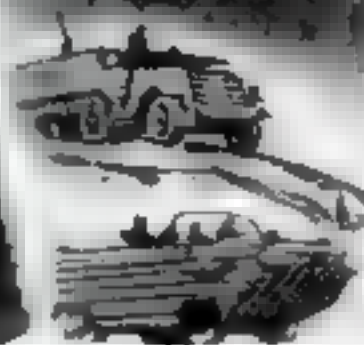
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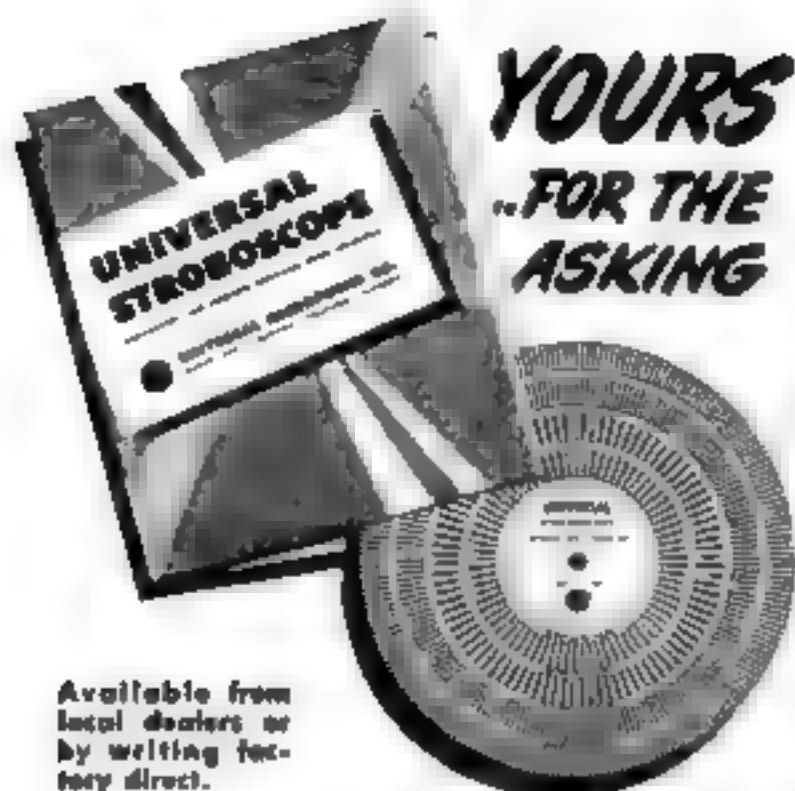
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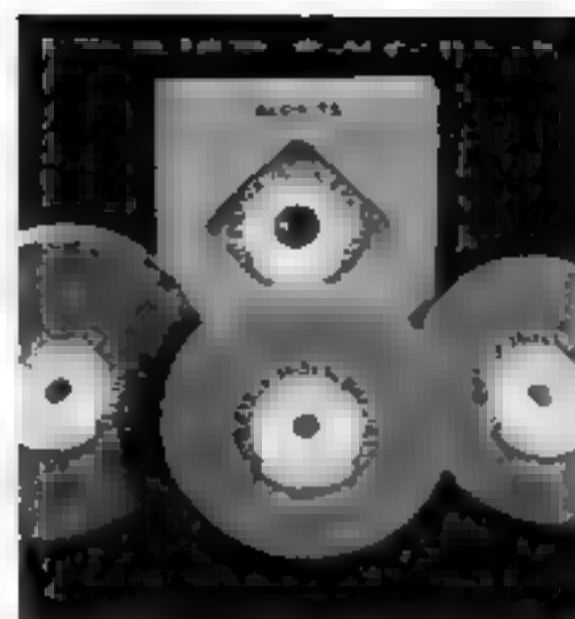


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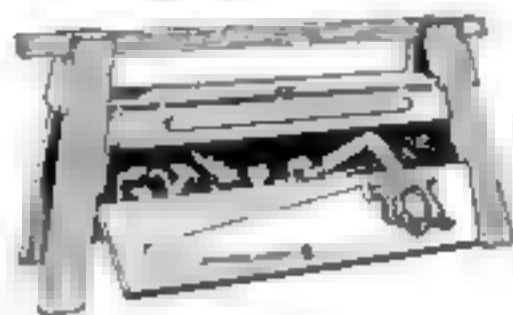
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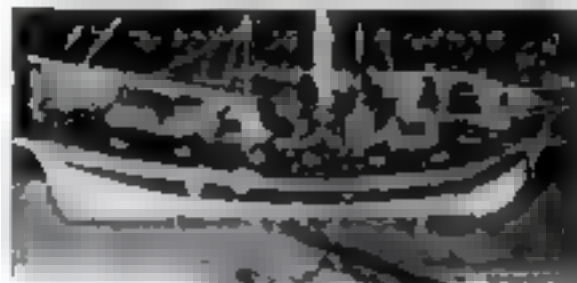


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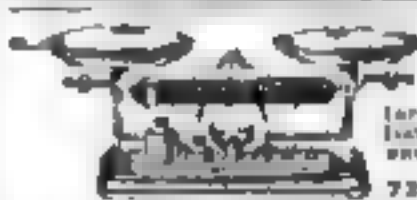


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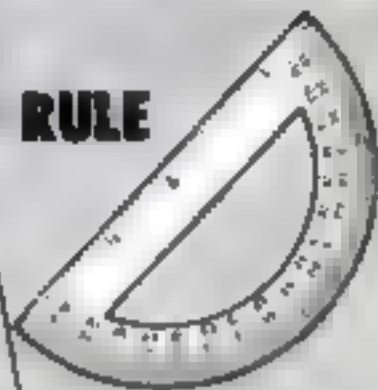
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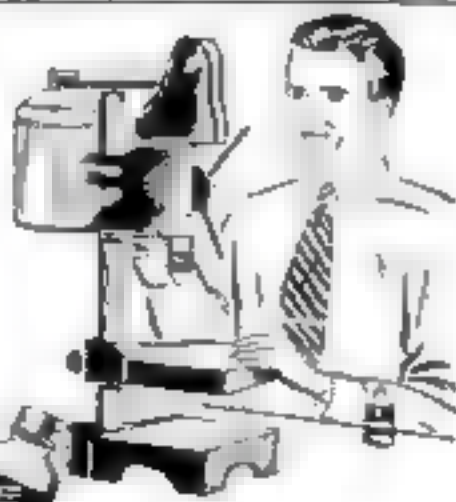
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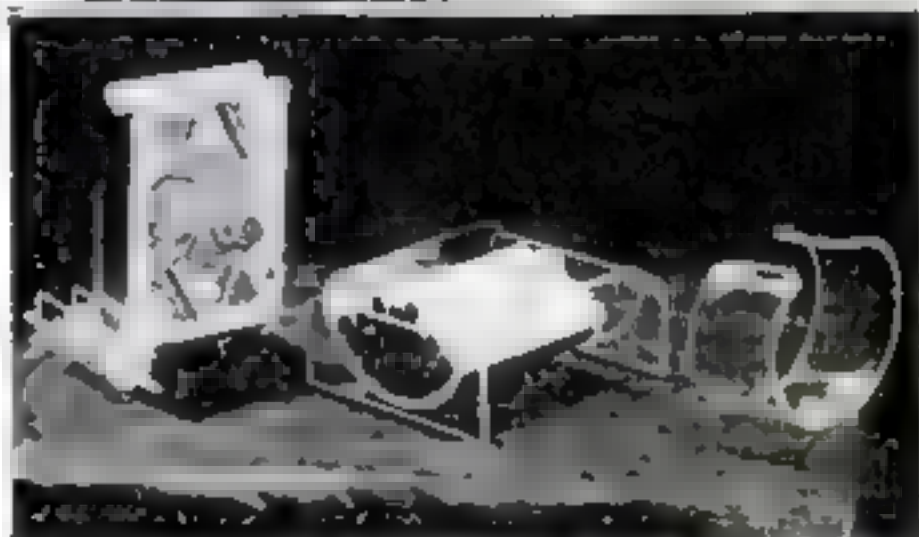
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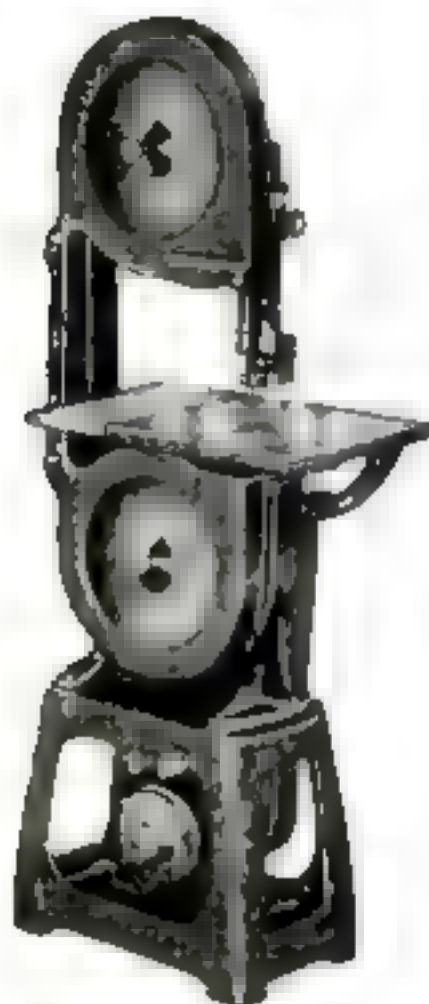
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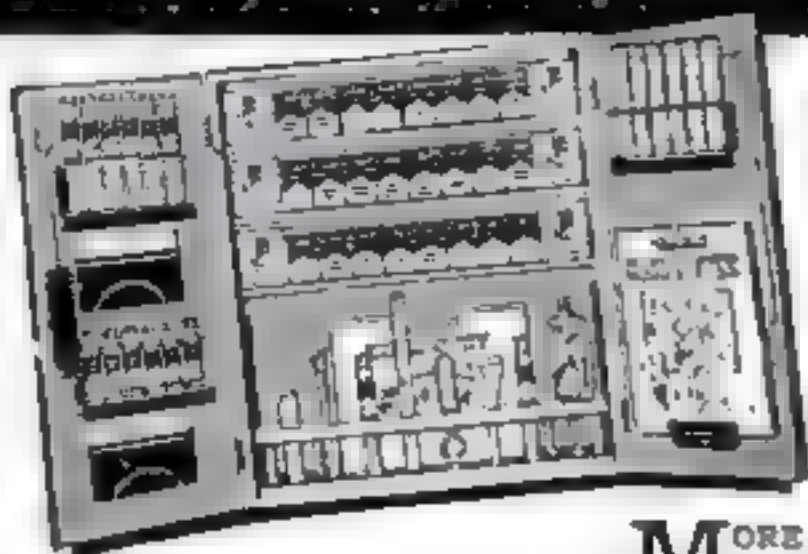
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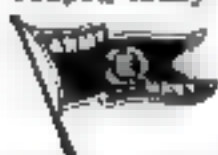
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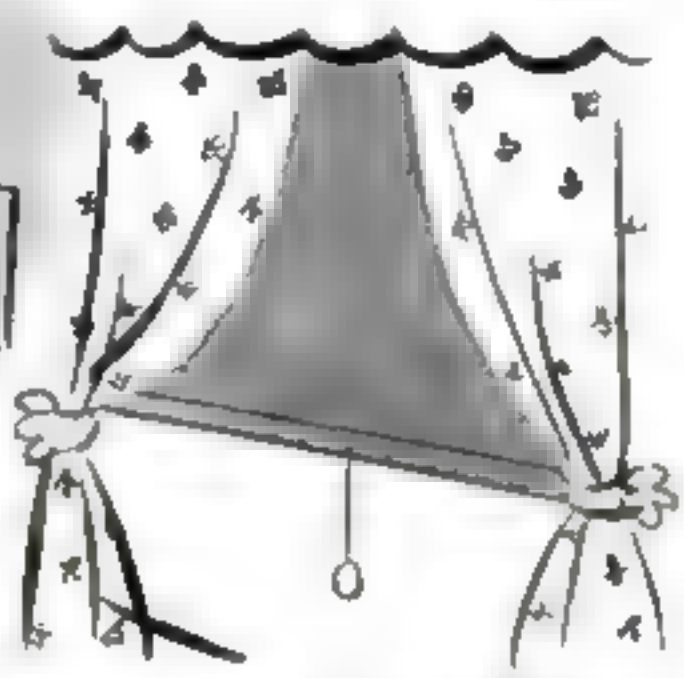
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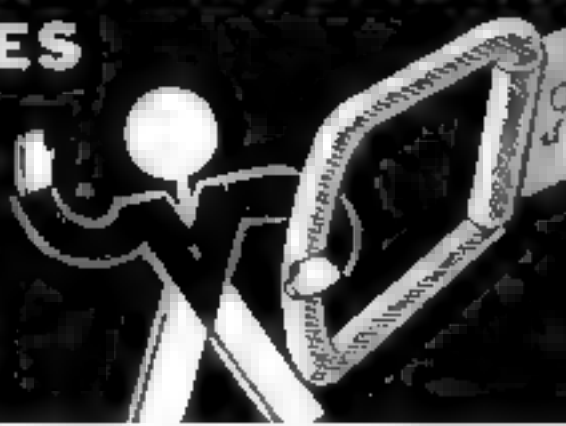
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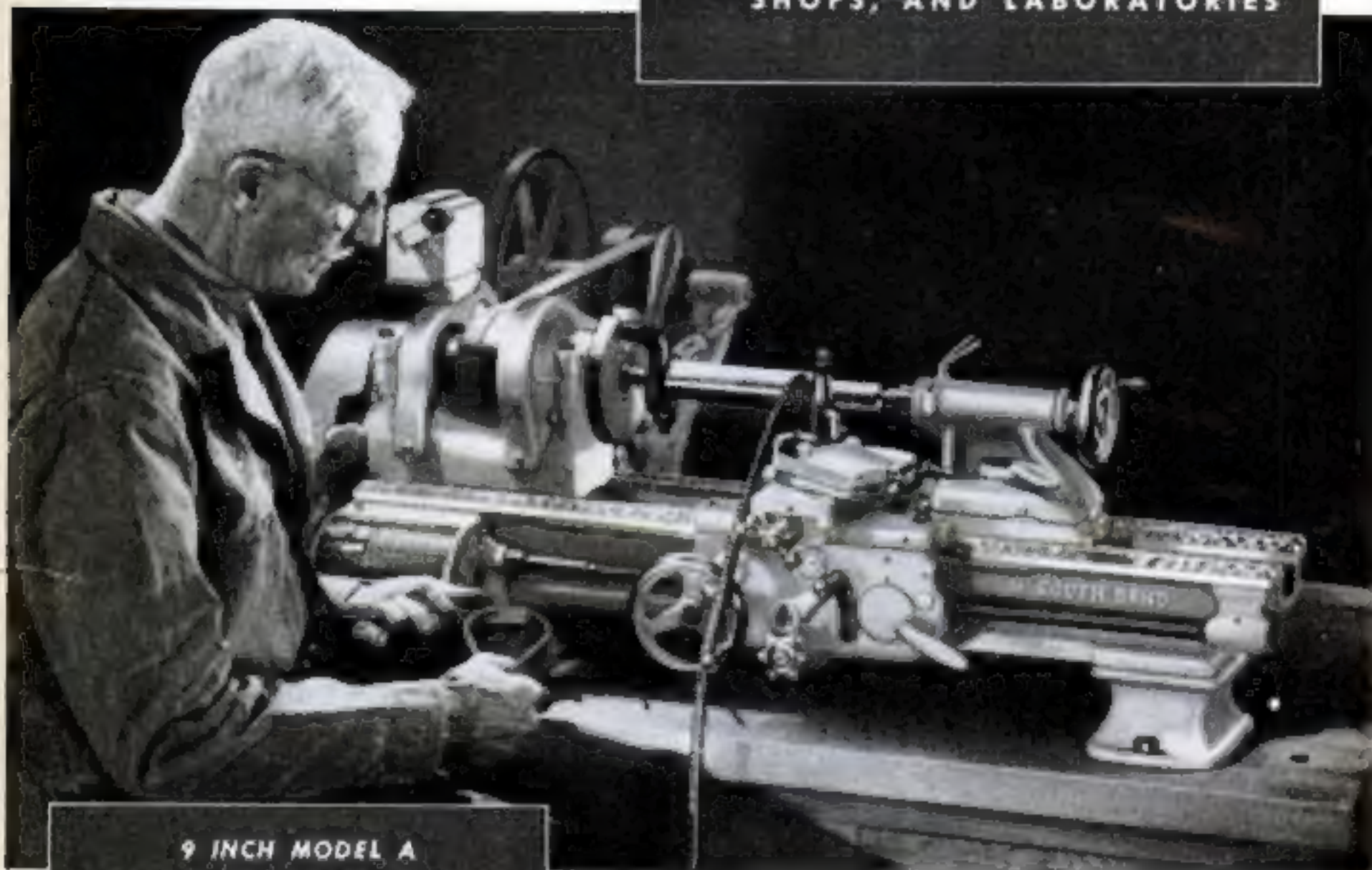
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